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1907.

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# LIST OF CONTENTS.

1907, pp. 1-446.

January 15, 1907.

	Page
The Secretary. Report on the Additions to the Society's Menagerie during the months of November and December, 1906.....	1
Mr. Oldfield Thomas, F.R.S., F.Z.S. Description of a new Monkey from the Ituri Forest. (Plate I.) .....	2
1. On a Collection of Mammals made by Dr. Vassal in Annam. By J. LEWIS BONHOTE, M.A., F.L.S., F.Z.S. (Plate II.) .....	3
2. On the "Bleating" or "Drumming" of the Snipe ( <i>Gallinago caelestis</i> ). By P. H. BAHR, B.A., F.Z.S. ....	12
3. Contributions to the Knowledge of the Systematic Arrangement and Anatomy of certain Genera and Species of Squamata. By FRANK E. BEDDARD, M.A., F.R.S., Prosector to the Society ....	35
4. A List of Moths of the Family <i>Pyralidæ</i> collected by A. E. Pratt in British New Guinea in 1902-3, with Descriptions of new Species. By GEORGE H. KENRICK, F.Z.S. (Plates III. & IV.).....	68

	Page
5. On some new and insufficiently known Species of Marmoset Monkeys from the Amazonian Region. By Prof. Dr. EMIL A. GOELDI, C.M.Z.S., Director of the Pará Museum.....	88

February 5, 1907.

Mr. F. Martin Duncan. Cinematograph exhibition of Animals in the Society's Gardens and other Zoological Subjects.....	100
Mr. Oldfield Thomas, F.R.S., F.Z.S. Exhibition of a collection of Mammals and Birds from the Islands of Saghalien and Hokkaido .....	100
Dr. W. T. Calman, F.Z.S. Notice of a paper on New or Rare Crustacea of the Order Cumacea from the Collection of the Copenhagen Museum .....	100
1. The Origin of the Lateral Horns of the Giraffe in Fœtal Life on the Area of the Parietal Bones. By E. RAY LANKESTER, M.A., D.Sc., LL.D., F.R.S., F.Z.S., Director of the Natural History Departments of the British Museum.....	100
2. Parallel Hair-fringes and Colour-stripping on the Face of Fœtal and Adult Giraffes. By E. RAY LANKESTER, M.A., D.Sc., LL.D., F.R.S., F.Z.S., Director of the British Museum (Natural History). (Plate V.) ...	115
3. On the Existence of Rudimentary Antlers in the Okapi. By E. RAY LANKESTER, M.A., D.Sc., LL.D., F.R.S., F.Z.S., Director of the British Museum (Natural History). (Plates VI. & VII.).....	126
4. Description of <i>Hyla resinificatrix</i> Goeldi, a new Amazonian Tree-Frog peculiar for its Breeding-habits. By Prof. Dr. EMIL A. GOELDI, C.M.Z.S., Director of the Pará Museum.....	135
5. The Duke of Bedford's Zoological Exploration in Eastern Asia. III. On Mammals obtained by Mr. M. P. Anderson in the Philippine Islands. By OLDFIELD THOMAS, F.R.S., F.Z.S. ....	140

## February 19, 1907.

	Page
The Secretary. Report on the Additions to the Society's Menagerie during the month of January 1907 .....	143
Dr. C. I. Forsyth Major, F.Z.S. Exhibition of remains of a Bear from a Cavern in Corsica .....	143
1. On English Domestic Cats. By R. I. Pocock, F.L.S., F.Z.S., Superintendent of the Zoological Society's Gardens. (Plates VIII.-X.) .....	143
2. Report on Deaths occurring in the Society's Menagerie during 1906. By C. G. SELIGMANN, M.D., F.Z.S., Pathologist to the Society .....	168
3. On a peculiarly Abnormal Specimen of Turbot. By J. T. CUNNINGHAM, M.A., F.Z.S. (Plate XI.) .....	174
4. On the Azygos Veins in the Mammalia. By FRANK E. BEDDARD, M.A. (Oxon.), F.R.S., Prosector to the Society 181	
5. Ideas on the Origin of Flight. By Dr. Baron FRANCIS NORCSA .....	223

## March 5, 1907.

The Hon. Walter Rothschild, M.P., F.Z.S. Exhibition of a mounted specimen of a Gorilla .....	237
1. Descriptions of a new Species and two new Subspecies of Antelopes and a new Sheep. By the Hon. WALTER ROTHSCHILD, M.P., Ph.D., F.Z.S. ....	237
2. On Elephant Remains from Crete, with Description of <i>Elephas creticus</i> , sp. n. By DOROTHEA M. A. BATE. (Plates XII. & XIII.) .....	238
3. Zoological Results of the Third Tanganyika Expedition, conducted by Dr. W. A. Cunningham, 1904-1905.—Report on the Polyzoa. By CHARLES F. ROUSSELET, F.R.M.S. (Plates XIV. & XV.) .....	250

	Page
4. Zoological Results of the Third Tanganyika Expedition, conducted by Dr. W. A. Cunningham, 1904-1905.—Report on the Brachyurous Crustacea. By WILLIAM A. CUNNINGTON, B.A., Ph.D., F.Z.S. (Plates XVI. & XVII.) .....	258
5. On Two new Species of the African Genus <i>Microchaetus</i> belonging to the Collection of Oligochaeta in the Museum of Christiania. By FRANK E. BEDDARD, M.A., F.R.S., Prosector to the Society .....	277

### March 19, 1907.

The Secretary. Report on the Additions to the Society's Menagerie during the month of February 1907 .....	281
Mr. Herbert F. Standing. Notice of a Memoir on recently discovered Subfossil Prosimiæ from Madagascar .....	281
1. Descriptions of some New Species of Animal Parasites. By L. W. SAMBON, M.D., F.Z.S. ....	282
2. Descriptions of five New Species of Hæmogregarines from Snakes. By L. W. SAMBON, M.D., F.Z.S., and C. G. SELIGMANN, M.D., F.Z.S. ....	283
3. The Rudd Exploration of South Africa.—VII. List of Mammals obtained by Mr. Grant at Coguno, Inhambane. By OLDFIELD THOMAS, F.R.S., F.Z.S., and R. C. WROUGHTON, F.Z.S. ....	285

### April 9, 1907.

Mr. R. I. Pocock. Exhibition of a photograph and the skull of a specimen of Pallas's Cat that had recently died in the Menagerie, with general remarks on the species ...	299
1. On a small Collection of Fishes made in the Eastern Watershed of the Transvaal by Capt. G. E. Bruce. By G. A. BOULENGER, F.R.S., F.Z.S. (Plates XVIII. & XIX.) .....	307
2. On the Winter Habits of the Greater Horseshoe, <i>Rhinolophus ferrum-equinum</i> (Schreber), and other Cave-haunting Bats. By T. A. COWARD, F.Z.S. ....	312

	Page
3. Notes upon the Anatomy of a Species of Frog of the Genus <i>Megalophrys</i> , with references to other Genera of Batrachia. By FRANK E. BEDDARD, M.A., F.R.S., Prosector to the Society .....	324
4. Contributions to the Osteology of Birds.—Part IX. <i>Tyranni</i> ; <i>Hirundines</i> ; <i>Muscicapæ</i> , <i>Lanii</i> , and <i>Gymno-</i> <i>rhines</i> . By W. P. PYCRAFT, F.Z.S., A.L.S., &c. ....	352
April 23, 1907.	
The Secretary. Report on the Additions to the Society's Menagerie during the month of March 1907 .....	379
Dr. A. Smith Woodward, F.R.S., F.Z.S. Exhibition of a malformed antler of the Red Deer .....	380
Mr. R. I. Pocock. Exhibition of a model of the African Elephant "Jumbo" .....	380
Mr. C. J. With. Notice of a Memoir entitled "An Account of the South-American <i>Cheliferinae</i> in the Collections of the British and Copenhagen Museums" .....	380
1. The Ears as a Race-Character in the African Elephant. By R. LYDEKKER ....	380
2. The Duke of Bedford's Zoological Exploration in Eastern Asia.—IV. List of small Mammals from the Islands of Saghalien and Hokkaido. By OLDFIELD THOMAS, F.R.S., F.Z.S. (With Appendix on the Cold-blooded Verte- brates, by G. A. BOULENGER, F.R.S., F.Z.S.).....	404
3. On some new Species of Earthworms of the Family <i>Eudrilidæ</i> , belonging to the Genera <i>Polytoreutus</i> , <i>Neu-</i> <i>manniella</i> , and <i>Eminoscolex</i> , from Mt. Ruwenzori. By FRANK E. BEDDARD, M.A., F.R.S. ....	415
4. Some Notes on Hybrid Bears. By HENRY SCHERREN, F.Z.S. ....	431





# ALPHABETICAL LIST

OF THE

## CONTRIBUTORS,

*With References to the several Articles contributed by each.*

(1907, pp. 1-446.)

	Page
BAHR, PHILIP HEINRICH, B.A., F.Z.S.	
On the "Bleating" or "Drumming" of the Snipe ( <i>Gallinago caelestis</i> ) ... ..	12
BATE, MISS DOROTHEA M. A.	
On Elephant Remains from Crete, with Description of <i>Elephas creticus</i> , sp. n. (Plates XII. & XIII.) .....	238
BEDDARD, FRANK E., M.A., F.R.S., Prosector to the Society.	
Contributions to the Knowledge of the Systematic Arrangement and Anatomy of certain Genera and Species of Squamata .....	35
On the Azygos Veins in the Mammalia .....	181
On Two new Species of the African Genus <i>Microchætus</i> belonging to the Collection of Oligochæta in the Museum of Christiania .....	277

BEDDARD, FRANK E. (*Continued.*)

Notes upon the Anatomy of a Species of Frog of the Genus *Megalophrys*, with references to other Genera of Batrachia. .... 324

On some new Species of Earthworms of the Family *Eudrilidae*, belonging to the Genera *Polytoreutus*, *Neumanniiella*, and *Eminoscolex*, from Mt. Ruwenzori ..... 415

## BONHOTE, J. LEWIS, M.A., F.L.S., F.Z.S.

On a Collection of Mammals made by Dr. Vassal in Annam. (Plate II.) ..... 3

## BOULENGER, GEORGE ALBERT, F.R.S., V.P.Z.S.

On a small Collection of Fishes made in the Eastern Watershed of the Transvaal by Capt. G. E. Bruce. (Plates XVIII. & XIX.) . .... 307

On the Cold-blooded Vertebrates of the Islands of Saghalien and Hokkaido. See THOMAS, OLDFIELD.

## CALMAN, WILLIAM THOMAS, D.Sc., F.Z.S., of the British Museum (Natural History).

Notice of a paper on New or Rare Crustacea of the Order Cumacea from the Collection of the Copenhagen Museum ..... 100

## COWARD, THOMAS ALFRED, F.Z.S.

On the Winter Habits of the Greater Horseshoe, *Rhinolophus ferrum-equinum* (Schreber), and other Cave-haunting Bats ..... 312

## CUNNINGHAM, JOSEPH THOMAS, M.A., F.Z.S.

On a peculiarly Abnormal Specimen of Turbot. (Plate XI.) ..... 174

	Page
CUNNINGTON, WILLIAM ALFRED, B.A., Ph.D., F.Z.S.	
Zoological Results of the Third Tanganyika Expedition, conducted by Dr. W. A. Cunningham, 1904-1905. —Report on the Brachyurous Crustacea. (Plates XVI. & XVII.).....	258
DUNCAN, F. MARTIN.	
Cinematograph exhibition of Animals in the Society's Gardens and other Zoological Subjects.....	100
GOELDI, Prof. Dr. EMIL A., C.M.Z.S.	
On some new and insufficiently known Species of Marmoset Monkeys from the Amazonian Region .....	88
Description of <i>Hyla resinifictrix</i> Goeldi, a new Amazonian Tree-Frog peculiar for its Breeding-habits .....	135
KENRICK, GEORGE HAMILTON, F.Z.S.	
A List of Moths of the Family <i>Pyralidæ</i> collected by A. E. Pratt in British New Guinea in 1902-3, with Descriptions of new Species. (Plates III. & IV.).....	68
LANKESTER, Sir EDWIN RAY, K.C.B., M.A., D.Sc., LL.D., F.R.S., Director of the British Museum (Natural History).	
The Origin of the Lateral Horns of the Giraffe in Fœtal Life on the Area of the Parietal Bones .....	100
Parallel Hair-fringes and Colour-stripping on the Face of Fœtal and Adult Giraffes. (Plate V.) .....	115
On the Existence of Rudimentary Antlers in the Okapi, (Plates VI. & VII.) .....	126

LYDEKKER, RICHARD, B.A., F.R.S., F.Z.S.

The Ears as a Race-Character in the African Elephant 380

MAJOR, Dr. C. I. FORSYTH, F.Z.S.

Exhibition of remains of a Bear from a Cavern in Corsica..... 143

MITCHELL, PETER CHALMERS, M.A., D.Sc., LL.D., F.R.S.,  
Secretary to the Society.

Report on the Additions to the Society's Menagerie during the months of November and December, 1906..... 1

Report on the Additions to the Society's Menagerie during the month of January 1907 ..... 143

Report on the Additions to the Society's Menagerie during the month of February 1907..... 281

Report on the Additions to the Society's Menagerie during the month of March 1907 ..... 379

NOPCSA, Dr. Baron FRANCIS.

Ideas on the Origin of Flight .. ..... 223

POCOCK, REGINALD INNES, F.L.S., F.Z.S., Superintendent of the Gardens.

On English Domestic Cats. (Plates VIII.-X.) ..... 143

Exhibition of a photograph and the skull of a specimen of Pallas's Cat that had recently died in the Menagerie, with general remarks on the species ..... 299

Exhibition of a model of the African Elephant "Jumbo" ..... 380

	Page
PYCRAFT, WILLIAM PLANE, F.Z.S., A.L.S., of the British Museum (Natural History).	
Contributions to the Osteology of Birds.—Part IX. <i>Tyranni; Hirundines; Muscicapæ, Lanii, and Gymno- rhines</i> .....	352
ROTHSCHILD, The Hon. L. WALTER, M.P., D.Sc., Ph.D., F.Z.S.	
Exhibition of a mounted specimen of a Gorilla . . . .	237
Descriptions of a new Species and two new Subspecies of Antelopes and a new Sheep .....	237
ROUSSELET, CHARLES F., F.R.M.S.	
Zoological Results of the Third Tanganyika Expedition, conducted by Dr. W. A. Cunningham, 1904–1905.—Report on the Polyzoa. (Plates XIV. & XV.) . . . . .	250
SAMBON, L. W., M.D., F.Z.S.	
Descriptions of some New Species of Animal Parasites.	282
SAMBON, L. W., M.D., F.Z.S., and SELIGMANN, C. G., M.D., F.Z.S., Pathologist to the Society.	
Descriptions of five New Species of Hæmogregarines from Snakes .....	283
SCHERREN, HENRY, F.Z.S.	
Some Notes on Hybrid Bears .....	431

	Page
SELIGMANN, C. G., M.D., F.Z.S., Pathologist to the Society.	
Report on Deaths occurring in the Society's Menagerie during 1906.....	168
SELIGMANN, C. G., M.D., F.Z.S., Pathologist to the Society, and SAMBON, L. W., M.D., F.Z.S.	
Descriptions of five New Species of <i>Hæmogregarines</i> from Snakes.....	283
STANDING, HERBERT F., M.Sc.	
Notice of a Memoir on recently discovered Subfossil Prosimiæ from Madagascar .....	281
THOMAS, OLDFIELD, F.R.S., F.Z.S.	
Description of a new Monkey from the Ituri Forest. (Plate I.) .....	2
Exhibition of a collection of Mammals and Birds from the Islands of Saghalien and Hokkaido .....	100
The Duke of Bedford's Zoological Exploration in Eastern Asia.—III. On Mammals obtained by Mr. M. P. Anderson in the Philippine Islands.....	140
The Duke of Bedford's Zoological Exploration in Eastern Asia.—IV. List of small Mammals from the Islands of Saghalien and Hokkaido. (With Appendix on the Cold-blooded Vertebrates, by G. A. BOULENGER, F.R.S., F.Z.S.) .....	404
THOMAS, OLDFIELD, F.R.S., F.Z.S., and WROUGHTON, R. C., F.Z.S.	
The Rudd Exploration of South Africa.—VII. List of Mammals obtained by Mr. Grant at Coguno, Inhambane.	285

	Page
WITH, C. J., of Copenhagen.	
Notice of a Memoir entitled "An Account of the South-American <i>Cheliferinæ</i> in the Collections of the British and Copenhagen Museums".....	380
WOODWARD, ARTHUR SMITH, F.R.S., F.Z.S., Keeper of the Geological Department of the British Museum.	
Exhibition of a malformed antler of the Red Deer.....	380
WROUGHTON, R. C., F.Z.S., and THOMAS, OLDFIELD, F.R.S., F.Z.S.	
The Rudd Exploration of South Africa.—VII. List of Mammals obtained by Mr. Grant at Coguno. Inhambane.	285





# LIST OF PLATES.

1907, pp. 1-146.

Plate	Page
I. <i>Cercopithecus denti</i> .....	2
II. <i>Nycticebus pygmaeus</i> .....	3
III. { Pyralidæ from British New Guinea .....	68
IV. {	
V. Head of a Fœtal Giraffe (half the natural size) .....	115
VI. Horn-tips of Okapi .....	126
VII. Young Ossicone or Horn of Okapi .....	
VIII. Blotched Tabby, <i>Felis catus</i> .....	143
IX. Striped Tabby, <i>Felis torquata</i> .....	
X. Agriotypes of the Striped Tabby ..	174
XI. Abnormal Young Turbot .....	
XII. { Elephant Remains from Crete .....	238
XIII. {	
XIV. { Tanganyika Polyzoa .....	250
XV. {	
XVI. 1. <i>Potamon (Potamonautes) orbitospinus</i> . 2 7. Antennal Region of various Potamonidæ ..	258
XVII. 1 & 3. <i>Potamon (Potamonautes) platynotus</i> . 2 & 4. <i>Platyl- thelphusa concubata</i> . 5 & 6. <i>Platylthelphusa maculata</i> }	
XVIII. 1. <i>Barbus brucei</i> . 2. <i>B. sector</i> .....	307
XIX. <i>Varicorhinus brucei</i> .....	



## LIST OF TEXT-FIGURES.

1907, pp. 1-446.

	Page
1. Palatal view of skull of <i>Nycticebus pygmaeus</i> .....	5
2. Lateral view of skull of <i>Nycticebus pygmaeus</i> .....	5
3. <i>a.</i> Snipe bleating, showing characteristic position. <i>b.</i> Formation of tail as ordinarily held in flight ..	16
4. Varieties of outer tail-feathers of <i>Gallinago caelestis</i> ....	18
5. <i>a.</i> Dorsal view of musculature of tail of Snipe. <i>b.</i> Ventral view of musculature of tail of Snipe .....	20
6. A. Half of tail of <i>Gallinago caelestis</i> from without inwards left to right. B. Half of tail of <i>G. delicata</i> from without inwards left to right. C. Half of tail of <i>G. gallinula</i> .....	22
7. A. Section of two rami of a feather showing interlocking of distal and proximal radii. B. Ramus of <i>Gallinago caelestis</i> , showing proximal and distal rows of radii. C. Distal radius of <i>G. caelestis</i> . D. Proximal radius. E. Distal radius of middle-tail feathers of <i>G. caelestis</i> .....	23
8. A. Half of tail of <i>Gallinago major</i> from without inwards left to right. B. Half of tail of <i>G. nobilis</i> from without inwards left to right. C. Half of tail of <i>G. stenura</i> .....	27
9. <i>a.</i> Tail of <i>Gallinago solitaria</i> . <i>b.</i> Tail of <i>G. megala</i> .....	31
10. Lung of <i>Chamaeleon verrucosus</i> , entire .....	38
11. Lung of <i>Chamaeleon dilepis</i> , entire .....	39
12. Lung of <i>Chamaeleon parvilobus</i> , opened longitudinally .....	39
13. Lung of <i>Chamaeleolis</i> , opened longitudinally .....	46
14. A. Stomach and pancreas of <i>Chamaeleolis</i> . B. Dorsal aorta and branches of the same .....	48
15. <i>Tiliqua scincoides</i> , head and neck .....	54
16. A portion of the trachea, the bronchi, and the upper parts of the lungs of <i>Heloderma</i> , from the dorsal side .....	61

	Page
17. Pancreas, gall-bladder, &c., of <i>Varanus niloticus</i> , to show the course of the bile-ducts .....	64
18. Lungs of <i>Varanus evanthematicus</i> .....	65
19. Lungs of <i>Varanus griseus</i> .....	66
20. Back view of head of <i>Midas thomasi</i> .....	89
21. Back view of head of <i>Midas rufirenter</i> .....	91
22. Back view of head of <i>Midas griseoverter</i> .....	93
23. Head of <i>Midas imperator</i> .....	94
24. Lateral view of the skull and lower jaw of a very young Giraffe .....	101
25. Lateral view of the skull of a Giraffe, about two-thirds grown ..	102
26. View from above of the fronto-parietal region of the skull of a very young Giraffe .....	102
27. View from above of the fronto-parietal region of the skull of an immature Okapi .....	103
28. Sagittal section through the bony tissue of the ossicone and the roof of the skull of a very young Giraffe .....	104
29. Copy of the drawing of a sagittal section through the ossicone and the roof of the skull of a newly-born Giraffe, published by the late Sir Richard Owen in the Trans. Zool. Soc. 1840..	104
30. Drawing of the right side of the head of the foetal Giraffe described in the text .....	106
31. The left 'horn' of the foetal Giraffe.....	107
32. Diagram to show the flattened plate-like form and the orientation of the horns of the foetal Giraffe .....	108
33. Skull of Giraffe.... showing the directions in which the skull was cut .....	110
34. View, looking forwards, of the skull cut in the direction of line 4 in text-fig. 33 .....	111
35. Drawing, of the natural size, of a young foetal skull of a Giraffe .....	112
36. Diagram to show the various positions on the frontal bone at which the bony horn-cores of the Cavicorn and Cervine ruminants may take their growth .....	114
37. Left side of the head of the foetal Giraffe described, showing colour-stripes on the snout and above and below the eye ....	115
38. Section across three dark-coloured bands above the eye of the foetal Giraffe, showing three longitudinal furrows or depressions in transverse section corresponding to the dark bands.....	116
39. Section of the skin of the frontal region of the foetal Giraffe, showing three sizes of hairs .....	117
40. Surface-view of banded "pelage" of the frontal region of foetal Giraffe, showing the convergence of the hairs at the three longitudinal bands of dark appearance .....	118
41. An enlarged drawing of a single hair of average size from the frontal region of an adult Giraffe, showing the dark pigmented free extremity and the opaque white lower portion .....	119

	Page
42. Colour-striping on the face of an adult male Giraffe from Kordofan .....	120
43. Colour-striping on the face of an adult female Giraffe from Kordofan .....	120
44. Colour-striping on the face of <i>Giraffa camelopardalis cottoni</i> from Mt. Elgon, Uganda .....	121
45. Colour-striping on the face and muzzle of a Transvaal Giraffe..	122
46. The same specimen as that shown in text-fig. 45, with colour omitted .....	123
47. Colour-striping on the face of a Somali-land Giraffe .....	124
48. The same specimen as that shown in text-fig. 47, with colour omitted .....	124
49. Drawing of a fore and aft section through the tip of the ossicone of an adult Okapi .....	126
50. Rudimentary free ossicone of hemispherical shape from the skin overlying the frontal bossed region of the skull of an Okapi of the broad-skulled type .....	128
51. Section of the ossicusp drawn in text-fig. 50, to show the incomplete ossification .....	128
52. Bisected horn-tip of the Edinburgh Okapi.....	131
53. Section of half of the same bisected horn-tip .....	131
54. Drawing of the right ossicone of the Okapi brought by Capt. Boyd Alexander from the Welle River .....	134
55. Section through the tip of the same specimen to show the incomplete trabeculated ossification .....	134
56. <i>Hyla resinifictrix</i> , male .....	136
57. <i>Hyla resinifictrix</i> (diagrammatic) .....	137
58. Breeding-basin of <i>Hyla resinifictrix</i> : (A) side view, and (B) section (diagrammatic) .....	138
59. Breeding-basin of <i>Hyla resinifictrix</i> , seen from above .....	139
60. Diagram of the Pattern of the Blotched Tabby ( <i>Felis catus</i> ) ..	154
61. Aorta of Tiger, showing several aneurysms .....	171
62. Azygos veins of <i>Cervicapra bohor</i> .....	186
63. Azygos veins of <i>Gazella euchoire</i> .....	187
64. Azygos veins of <i>Phacochærus æthiopicus</i> .....	189
65. Azygos veins of <i>Tragulus meminna</i> .....	191
66. <i>Hyrax capensis</i> ; two different arrangements of azygos system .	194
67. Azygos veins of <i>Erinaceus algirus</i> .....	196
68. Azygos of <i>Hyæna crocuta</i> .....	199
69. Azygos of <i>Crossarchus obscurus</i> .....	200
70. Azygos veins of <i>Halmaturus bennettii</i> .....	203
71. Azygos veins of <i>Phascodomys mitchelli</i> .....	204
72. Azygos veins of <i>Hystrix cristata</i> .....	211
73. Lateral view of the thoracic region of newly born <i>Myopotamus coypu</i> .....	214
74. Hind limb of <i>Dimorphodon</i> .....	224
75. Hind limbs of <i>Rhamphorhynchus</i> .....	225
76. Hind limb of <i>Pterodactylus</i> .....	226

	Page
77. Hind limb of <i>Nyctodactylus</i> .....	227
78. Hind limb of <i>Hipposiderus</i> .....	230
79. Hind limb of <i>Ornithomimus</i> .....	232
80. Hind limbs of <i>Dipus</i> (left) and <i>Alactaga</i> (right) .....	232
81. Hind limb of <i>Archaeopteryx</i> .....	233
82. Hypothetical reconstruction of a running "Pro-Avis" .....	235
83. Right mandibular ramus of <i>Elephas antiquus</i> (?) bearing two lower molars .....	245
84. <i>Platythelphusa armata</i> , large male .....	269
85. <i>Microchaetus colletti</i> .....	278
86. <i>Microchaetus zuluensis</i> .....	280
87. <i>Felis manul</i> .. .. .	300
88. Skull of <i>Felis manul</i> , view from above .....	304
89. Skull of <i>Felis manul</i> , side view .....	305
90. <i>Barbus polylepis</i> .....	308
91. <i>Barbus elephantis</i> .....	310
92. Palmar surface of hand and foot of <i>Megalophrys nasuta</i> .....	326
93. Part of dorsal musculature of <i>Megalophrys nasuta</i> .....	332
94. Some of the dorsal muscles of <i>Rana guppyi</i> .....	333
95. A dissection of <i>Pelobates fuscus</i> , to show large oesophageal sheet of the transversalis .....	334
96. Some of the dorsal muscles of <i>Ceratophrys ornata</i> .....	336
97. Hyoid of <i>Megalophrys nasuta</i> .....	341
98. The oesophageal sheet of transversalis muscle in <i>Megalophrys nasuta</i> .....	346
99. Liver and adjacent viscera of <i>Rana guppyi</i> .....	349
100. Oviduct of <i>Megalophrys nasuta</i> .....	350
101. Lateral aspects of the skulls of:— a. <i>Gymnorhina organicum</i> . b. <i>Laniarius poliocephalus</i> . c. <i>Sayornis cineracea</i> .....	355
102. Ventral aspects of the skulls of:—a. <i>Artamus leucogaster</i> . b. <i>Sayornis cineracea</i> . c. <i>Terpsiphone</i> . d. <i>Pitta bauli</i> . e. <i>Vireolanius leucotis</i> . f. <i>Vireo olivacea</i> .....	362
103. Ventral aspects of the skulls of:—a. <i>Lanius collurio</i> . b. <i>Para- disa raggiana</i> . c. <i>Gymnorhina organicum</i> . .....	363
104. Phylogenetic tree indicating the probable relationships of the Passeres Oligomyodii and Discomyodii .....	377
105. Head of the Addo Bush, or East Cape Elephant ( <i>Elephas africanus capensis</i> ) .....	383
106. Head of Female West Cape Elephant ( <i>Elephas africanus torotis</i> ) .....	385
107. Head of Male West Cape Elephant ( <i>Elephas africanus torotis</i> ) .....	386
108. Head of Male Mashonaland Elephant ( <i>Elephas africanus selousi</i> ) .. .. .	387
109. Right Ear of Male Mashonaland Elephant ( <i>Elephas africanus selousi</i> ) .....	388
110. Head of Male Elephant from Swaziland .....	389
111. Right Ear of the Congo Elephant ( <i>Elephas africanus cyclotis</i> ?) ..	390

	Page
112. Head of a Male Elephant from North-west Rhodesia .....	391
113. Head of Male Elephant from Fort Manning, N.E. Rhodesia ( <i>Elephas africanus knochenaueri</i> ?) .....	392
114. Head of Male Elephant from the Aberdare Mountains, British East Africa .....	393
115. Head of Male Elephant from the Lake Rudolf District ( <i>Elephas africanus cavendishi</i> ) .....	394
116. Head of the "Queen's Elephant," an immature Male Sudan Elephant .....	396
117. Right Ear of a Male Sudan Elephant ( <i>Elephas africanus oxyotis</i> ) .....	397
118. Right Ear of the North Somali Elephant ( <i>Elephas africanus orleansi</i> ) .....	398
119. Head of "Jumbo," the male West Sudan Elephant formerly belonging to the Society.....	400
120. Front view of the Skull of the Sudan Elephant ( <i>Elephas africanus oxyotis</i> ).....	401
121. Front view of the Skull of the Albert Nyanza Elephant ( <i>Elephas africanus albertensis</i> ) .....	402
122. Spermathecal sac of <i>Polytoreutus ruenzorii</i> .....	418
123. Terminal male organs of <i>Polytoreutus granti</i> .....	421
124. Spermathecal sac of <i>Polytoreutus granti</i> ...	422
125. Spermathecal apparatus of <i>Neumanniella ruenzorii</i> .....	426
126. Ventral view of <i>Eminoscœler ruenzorii</i> ...	428
127. Terminal male organs of <i>Eminoscœler ruenzorii</i> ...	430



## LIST OF NEW GENERIC TERMS

PROPOSED IN THE PRESENT VOLUME (pp. 1-446).

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	Page		Page
Monodonta (Insecta).....	69		Tipuliforma (Insecta) . . . .. 75

PROCEEDINGS  
OF THE  
GENERAL MEETINGS FOR SCIENTIFIC BUSINESS  
OF THE  
ZOOLOGICAL SOCIETY OF LONDON.  
(January to April, 1907.)

January 15, 1907.

Dr. J. ROSE BRADFORD, F.R.S., Vice-President,  
in the Chair.

The Secretary read the following report on the additions that had been made to the Society's Menagerie in November and December 1906 :—

The registered additions to the Society's Menagerie during the month of November were 173 in number. Of these 105 were acquired by presentation and 23 by purchase, 35 were received on deposit, 3 in exchange, and 7 were born in the Gardens. The total number of departures during the same period, by death and removals, was 177.

Amongst the additions special attention may be directed to :—

An adult male Mandrill (*Papio maimon*), the first full-sized example of this species exhibited in the Gardens, deposited on Nov. 30th.

A young female Hippopotamus (*Hippopotamus amphibius*) from the Niger, purchased on Nov. 1st.

A Persian Stag (*Cervus maral*), presented on Nov. 13th by Mr. Carl Hagenbeck.

A Kashmir Stag (*Cervus cashmiriensis*), presented on Nov. 22nd by H.G. the Duke of Bedford, K.G., P.Z.S.

A Collection of 47 Birds, including, among other interesting species, a Toucan (*Aulacorhamphus sulcatus*), new to the Collection,

and a Sun-Bittern (*Eurypyga helius*) from Venezuela, presented on Nov. 27th by Capt. A. Pam, F.Z.S.

The registered additions to the Society's Menagerie during the month of December were 150 in number. Of these 67 were acquired by presentation and 16 by purchase, 61 were received on deposit, 2 in exchange, and 4 were born in the Gardens. The total number of departures during the same period, by death and removals, was 207.

Amongst the additions special attention may be directed to:—

A pair of Siberian Dholes (*Canis alpinus*) from Thian Shan, received in exchange on Dec. 2nd, new to the Collection.

A Cape Hunting-Dog (*Lycaon pictus*) from South Africa, purchased on Dec. 1st.

An Addax Antelope (*Addax nasu-maculatus*) from North Africa, presented by H.G. the Duke of Bedford, K.G., P.Z.S., on Dec. 18th.

A Bubaline Hartebeest (*Alcelaphus bubalinus*), and a hybrid between Père David's Deer (*Elaphurus davidianus*) and the Red Deer (*Cervus elaphus*), deposited on Dec. 29th.

#### *A new Monkey from the Ituri Forest.*

Mr. Oldfield Thomas, F.R.S., F.Z.S., exhibited a Monkey which had been obtained in the Ituri Forest, Upper Congo, during the recent Ruwenzori Expedition, and gave the following description of it:—

*CERCOPITHECUS DENTI* THOS.\* (Plate 1.)

Abstr. P. Z. S. 1907, p. 1 (Jan. 22, 1907).

A member of the *campbelli-mona* group, but not darkened on the posterior back and hind limbs, and with a very sharply contrasted white belly.

Upper surface of head and neck olive-grey, the usual light frontal band present but not conspicuous. Back dark grizzled chestnut-brown (nearest to "burnt-umber" of Ridgway); colour of rump not darker, but, on the contrary, passing gradually into the paler tone of the hips and hind legs. Under surface from chin to anus, and inner sides of limbs to wrists and ankles, clear creamy-white, very sharply defined from the darker colour, not only on the limbs, as in *campbelli* and others, but also along the flanks, where the white rises nearly halfway up the lateral aspect of the animal. Ears with short yellowish tufts rising from their inner surfaces. Outer sides of fore limbs deep black from elbows. Hind limbs grizzled yellowish olive, lighter than the back, down to and including the ankles, the metatarsals and toes black. Tail indistinctly blackish above at base, then dull greyish white for two-thirds its length, darkening again to black on its terminal third.

\* [The complete account of the new species described in this communication appears here; but since the name and preliminary diagnosis were published in the 'Abstract,' the species is distinguished by the name being underlined.—EDITOR.]



J. Smit del et lith

B. de & Danielsson, l. d. imp.

CERCOPITHECUS DENTI



H. Godechald, del et lit.

Huth, imp

NYCTIOEBUS PYGMAEUS.

Dimensions of the type, measured in the flesh :—

Head and body 501 mm.; tail 850; hind foot 155; ear 40.

Skull—greatest length 105 mm., basal length 75; breadth of brain-case 55; length of upper cheek-tooth series 23.

*Hab.* Ituri River, between Mawambi and Avakubi, Upper Congo; alt. 3000'.

*Type.* Adult male. B.M. no. 7.1.2.1. Original number 184. Collected 23 October, 1906, by R. E. Dent.

This handsome Monkey is most nearly allied to the W. African *C. campbelli*, but differs by its grizzled olive-yellowish instead of black hind limbs, the absence of black on its posterior back, its more or less greyish-white tail, and by the high and sharply defined line separating the colours of the flanks and belly.

The following papers were read :—

1. On a Collection of Mammals made by Dr. Vassal in Annam. By J. LEWIS BONHOTE, M.A., F.L.S., F.Z.S.\*

[Received November 16, 1906.]

(Plate II.† and Text-figures 1, 2.)

The British Museum has recently acquired a most interesting set of Mammals from Annam, collected by Dr. Vassal. The collection contains examples of some twenty-five species, of which five are new to science, while several of the others add considerably to our knowledge (still very limited) of the fauna of the district.

Since the collections made by MM. Pierre and Mouhot over half a century ago, practically no fresh material has reached Europe from that locality. As would therefore be expected, many of the forms are undescribed, and there is little doubt that with further material many of the forms at present included under existing names will prove to be subspecifically distinct.

The collection is, perhaps, too small for any generalisation on the fauna of Annam, but its affinities seem if anything to tend towards China rather than the Malay Peninsula, and it is especially noteworthy that it differs considerably from the fauna of Siam. Lest I am misunderstood, I may as well point out that by "fauna" I am not referring to the presence or absence of certain genera, but rather to the fact that the local forms of widely spread species approximate rather to the Chinese than to the Malayan. To give some examples:—The Porcupine is Anderson's *Hystrix yunnanensis*, not *H. grotei* from the Peninsula. The *Petaurista* is Anderson's *P. yunnanensis*, and not *P. lylei*, mihi, from Siam. The new *Tupaia* described has its affinities with *T. chinensis* and

† For explanation of the Plate, see p. 11.

not with *T. ferruginea*. On the other hand, the *Paradoxurus* is apparently identical with a form described by me from the Peninsula. Another point of interest as showing a probable double origin for this fauna, is in the occurrence at the same place of two subspecies of *Sciurus maclellandi*—one, *S. m. rodolphi* A. M.-E., showing very obvious affinities with *S. m. barbei* of the Peninsula; the other, *S. m. maritimus* mihi, which is indistinguishable from the type, which came from China. It must, however, be remembered that this last is only represented by a single skin, and it might possibly have been brought down on a ship and escaped.

Lastly, attention may be called to a new species of *Nycticebus*, which is in many respects intermediate in its characters between *Nycticebus* and *Loris*.

As regards synonymy, I have followed my usual custom, namely, to give the original reference and a few of the other more important ones, which, if referred to, will be found to contain a practically full synonymy.

#### PRESBYTES NIGRIPES (A. M.-E.).

*Semnopithecus nigripes* A. M.-Edw. Nouv. Arch. du Mus. vol. vi., Bull. p. 7, pl. 1 (1871); Blyth, J. A. S. B. xliv. ex. no. p. 11 (1875); Anders. Zool. Res. p. 41 (1879).

a. ♂ ad. Bali, alt. 250 m., 10th Nov., 1905.

This is an extremely fine example of this scarce species, agreeing very well with the published descriptions.

#### PRESBYTES sp. ?

a, b. ♀. Nha-trang, 30th Oct., 1905.

Two very young specimens of a species of *Presbytes*, unfortunately too young for identification.

#### NYCTICEBUS PYGMEUS Bonh. (Plate II.)

Abstr. P. Z. S. 1907, p. 2 (Jan. 22, 1907).

Very small, about half the size of *N. coucang*\* Bodd. The hair is wavy on the body and of a very fine silky texture. General colour of a uniform orange-rufous, showing no sign of any dark line down the back or on the head. The under parts, hands, and feet are lighter in colour and have a silvery-grey appearance. There is a bare space round the eyes, the muzzle and lips are white, and a white stripe runs up from the nose between the eyes to end abruptly on the forehead. The ears are of moderate size, uniformly rounded, and very sparsely covered with hairs. The tail is a mere stump.

The skull in its general outline agrees fairly well with that of *N. c. cinereus* from Cochin China, although it is, of course, very much smaller. In its main characters also it shows no very

\* Messrs. Stone and Rehn have pointed out (Proc. Acad. Nat. Sci. Phil. 1902, p. 138) that the name *tardigradus* belongs to the Slender Loris "*L. gracilis*," and that therefore Boddaert's name must stand for the Slow Loris usually known as *N. tardigradus*.

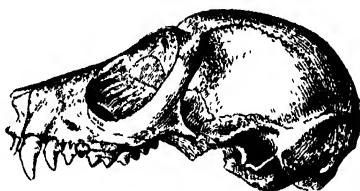
distinctive points. The molars, however, are conspicuously different, and enable this species to be easily diagnosed. In *N. cinereus* the first molar is the largest, and the last or third molar is small and almost quadrilateral in shape. In the present species, however, the *second* molar is the largest, while the third molar is triangular in outline and not very much smaller than the first molar. In the lower jaw similar conditions obtain, the three molars are all subequal, the third being slightly the largest, whereas in *N. cinereus* the last molar in the lower jaw is very markedly smaller than either of the other two.

*Dimensions* of type from skin (approx.). Head and body 190 mm.; tail 10.

Text-fig. 1.



Text-fig. 2.

Text-fig. 1 -- Palatal view of skull of *Nycticebus pygmaeus*.Text-fig. 2. Lateral view of skull of *Nycticebus pygmaeus*.

*Skull.* Greatest length 46 mm.; basal length 38; palatal length 17.5; zygomatic breadth 27; interorbital breadth 3; greatest breadth of brain-case 25; length from palate to lower margin of foramen magnum 17.5; breadth of basioccipital at its anterior end 3.7; length of molar series 14.

*Hab.* Nha-trang, Annam.

*Type.* B.M. 6.11.6.2. ♂. Collected by Dr. Vassal on the 13th Nov., 1905.

The small size and peculiar character of the teeth will prevent this species from being confounded with any others at present known to exist. Only a single specimen (the type) has been sent, which is quite adult but not old. It may be noted that in some respects the teeth tend to approach those in *Loris*, in which the second upper molar is larger than the first. In the shape of the premaxilla also the present species shows a tendency, albeit very slight, to approach *Loris* by showing its flat surface laterally instead of anteriorly. Externally the blaze between the eyes and its small size are features belonging to *Loris*, but in the length of its limbs and general build it is a true *Nycticebus*.



**FELIS** sp. ?

- a. Flat skin with no data of a Cat belonging apparently to the *Felis bengalensis* group.

**VIVERRA MEGASPILA** Blyth.

*Viverra megaspila* Blyth, J. A. S. B. xxxi. p. 331 (1862).

- a. Nambon, Annam.

A fine adult specimen with well-marked and clear-cut spots.

**VIVERRICULA MALACCENSIS** (Gmel.).

*Viverra malaccensis* Gmel., Linn. Syst. Nat. i. p. 92 (1788); Gray, P. Z. S. 1861, p. 136.

*Viverricula malaccensis* (Gmel.), Bonhote, Ann. & Mag. N. H. ser. 7, vol. i. p. 118 (1898).

- a. Imm. No data.

**PARADOXURUS MINOR** Bonh.

*Paradoxurus minor* Bonh. Fasci. Mal., Zool. i. p. 9 (1903).

- a, b. ♀ imm. Bali, Annam, 250 m., 10th Nov., 1905.

These are both very young specimens, which agree closely with the type.

**HERPESTES EXILIS** Gerv.

*Herpestes exilis* Gerv. Zool. de la Bonite, p. 32 (1841); Gray, P. Z. S. 1864, p. 555.

*Herpestes javanicus* (Geoff.), Anders. Zool. Res. p. 185 (1879).

*Herpestes rutilus* Gray, P. Z. S. 1861, p. 136.

*Calogale rutilus* Gray, P. Z. S. 1864, p. 561.

- a, b. ♀. Nha-trang, 26th Dec., 1905.

I have carefully compared these specimens with some from Siam and others from Cochin China, among them Gray's type of *H. rutilus*. The Cochin China and Annam specimens are all very like each other, and differ in their much redder colour from Siamese specimens. They also differ in their much deeper colour from Javan specimens. Gervais's type of *H. exilis* came from Cochin China, and as his description agrees fairly well with these fresh specimens, his name of *H. exilis*, which antedates Gray's, must stand.

The skulls of *H. exilis*, although very similar to those from Siam and Java, are larger and more robust. The Siamese animal is apparently intermediate between *H. birmanicus* and *H. exilis*.

The following is a description of the present specimens:—General colour rufous, punctulated with white. Each hair is black, with three or four buff or rufous annulations. The distal annulations and generally the tip of each hair are rufous, while along the centre of the back, the head, cheeks, and tail these rufous annulations are deeper in colour and more marked, causing the animal to appear quite red along those areas. The under parts are more sparsely covered with hairs and the annulations

yellowish rather than rufous, except under the chin and at the root of the tail. The hairs of the tail, more especially underneath and at the sides, have long rufous tips.

*Dimensions* (of Nha-trang specimen, ad. ♀ in flesh). Head and body 364 mm.; tail 284; ear 28.

*Skull*. Greatest length 78 mm.; basal length 75; zygomatic breadth 39; palatal length 41; greatest diameter of carnassial 8.

**HELICTIS PIERREI** Bonh.

*Helictis pierrei* Bonhote, Ann. & Mag. Nat. Hist. ser. 7, vol. xii. p. 592 (1903).

a. Imm. Nha-trang, Annam.

b. Imm. skull only.

The single skin and skull are too immature to show the distinctive characters to any marked extent.

**TUPAIA CONCOLOR** Bonh.

Abstr. P. Z. S. 1907, p. 2 (Jan. 22, 1907).

Similar in general colouring to *Tupaia belangeri*. The whole of the upper parts are of a uniform grizzled greyish-green, each hair being dark at its base and having one or more buff annulations and a dark tip. One of the most distinctive features is the absence of the neck-stripe, so universal among the other species of this genus. An extremely faint trace of it only is to be made out on the shoulders, but so faint is it that unless special search be made it is liable to be overlooked. The tail, which is markedly distichous, is concolorous with the upper parts, and extremely thick and bushy. The under parts are somewhat sparsely clothed with hair; the chin, throat, and breast are uniformly yellow, while on the other portions the hairs are annulated as on the upper parts. The bases of the hairs on the under side of the tail are light.

*Skull*. In its general character resembles that of *T. belangeri*; it is, however, slightly larger and with a longer and narrower snout, in other respects it does not show any marked features.

*Dimensions* of type (from skin). Head and body 220 mm.; tail 140; ear 15; hind foot 45.

*Skull*. Greatest length 54 mm.; basal length 47; zygomatic breadth 29; palatal length 27; breadth of skull immediately behind postorbital processes 17.

*Type*. B.M. 6.11.6.3. ♂ ad. Collected by Dr. Vassal, 22nd March, 1906.

*Hab.* Annam.

Although very closely allied to *Tupaia belangeri* this species may easily be distinguished by its larger size, much thicker tail, and the absence of the light neck-stripe. Two specimens agreeing in all respects were brought back by Dr. Vassal. *Tupaia chinensis*, described by Dr. Anderson from Yunnan and which is found in Siam, is rather smaller than *T. belangeri* and consequently quite distinct from the present form.

**DENDROGALE FRENATA** Gray.

*Thupaia frenata* Gray, Ann. & Mag. Nat. Hist. ser. 3, vol. vi. p. 217 (1860).

*Dendrogale frenata* Anders. Zool. Res. p. 110, pl. 7. figs. 20, 21 (1879).

*a, b.*

Two very typical examples.

**CYNOPTERUS SPHINX** (Vahl).

*Vespertilio sphinx* Vahl, Skrifter af Naturhistorie-Selskabet, 4te Band, 1ste Heft, p. 123 (1797).

*Cynopterus sphinx* (Vahl), Bonh. P. Z. S. 1902, vol. i. p. 38; id. Fasci. Mal., Zool. pt. i. p. 14 (1903).

*a. ♂.* Nha-trung, Annam, 13th Nov., 1905.

**SCOTOPHILUS KUHLLI** Leach.

*Scotophilus kuhlii* Leach, Trans. Linn. Soc. xiii. p. 71 (1822).

*a, b. ♂.* Nha-trung, 10th Oct., 1905.

**PETAURISTA YUNNANENSIS** (Anders.).

*Pteromys yunnanensis* Anders. Zool. Res. p. 282, pl. xxii. (1879).

*a. ♂ ad.* Bali, Annam, 150 m., 10th Nov., 1905.

This individual agrees very well with Dr. Anderson's description and plate (quoted above), and I have no alternative but to place it under his name. At the same time it should be noted that the typical locality of *P. yunnanensis* is considerably to the north and that another form of this same species, *P. lylei* mihi, is found in Siam. It would therefore appear as if the present race was in reality a Chinese form and that Annam and Yunnan form its western limit. Except for the parachute the hairs of the whole of the back in this individual are tipped with white, but not sufficiently so as to conceal the chestnut ground-colour.

*P. lylei* is much darker in general coloration than this species and the anterior portion of the outer side of the ear is a bright and pure chestnut.

*P. yunnanensis* and *P. lylei* belong to a large group, of which there are many geographical forms. Until, however, the group is worked out as a whole, it is best to retain them under binomial names, but it should be borne in mind that they are merely geographical forms of a large and widely distributed species.

**SCIURUS GRISEIMANUS** A. M.-E.

*Sciurus griseimanus* A. M.-Edw. Rev. Zool. 1867, p. 195; Bonh. Ann. & Mag. Nat. Hist. ser. 7, vol. vii. p. 274 (1901).

*a-d. 3 ♂, ♀.* Nha-trung, Annam, 26th Dec., 1905.

*e.* Nha-trung, Annam, Nov. 1905.

*f k. 3 ♂, 2 ♀.* Hoah Khat, Annam, 26th Dec., 1905.

*l-n. 2 ♂, ♀.* Ninh Hoa, 25th Dec., 1905.

*o-p. ♂ ♀.* Bali, Annam, 250 m. alt., 26th Dec., 1905.

The present species and *S. leucopus*\* of Gray have hitherto been confounded and considered as one and the same species. The

\* *Macrosc. leucopus* Gray, Ann. & Mag. N. H. ser. 3, xi. p. 282 (1867).

present series, however, shows that they are really quite good and distinct species. The most obvious difference is in the colour of the under parts. In *S. griseimanus* they are deep chestnut and the line of demarcation between the upper and under parts is sharply divided. In *S. leucopus*, on the other hand, the colour of the under parts is of a pale rufous buff, which shades gradually into the grizzled grey of the back. M. Milne-Edwards in his original description of *S. griseimanus* distinctly states that the colour of the under parts is deep chestnut, though females and young males are sometimes considerably lighter. This enables us to fix M. Milne-Edwards's name on the chestnut-bellied form without hesitation. In the present series the colour of the under parts is very deep chestnut and shows but little variation; the two examples from Bali, at an altitude of 250 metres, are, however, much lighter below, and it may be that these lighter individuals represent a mountain race of *S. griseimanus*, but our material is at present too scanty to settle that question.

*S. leucopus* differs still further from *S. griseimanus* in the annulations on the hairs of the back being yellower and not of such a clear grey, thus giving the animal a darker appearance. The colour of the under parts also extends over the outer sides of the limbs and is especially noticeable on the thighs.

*SCIURUS LEUCOPUS FUMIGATUS*\* Bonh.

Abstr. P. Z. S. 1907, p. 2 (Jan. 22, 1907).

General colour above similar to that of *S. leucopus*, but darker (see preceding species). Each hair is very dark, with three or four yellowish annulations. The tail, which is indistinctly barred, is similar in colour to the body, but the annulations are of a slightly deeper tint. Hands and feet dirty yellowish white grizzled with darker. Under parts and inner sides of the limbs pale reddish buff, with the exception of the chin and throat which are grizzled like the back.

The skulls available are so imperfect that a description is not possible.

*Dimensions* of type (from skin). Head and body 190 mm.; tail 175; ear 17; hind foot 52.

*Hab.* Ninh Hoa, Annam.

*Type.* B.M. 6.11.6.25. Collected on the 10th Nov., 1905, by Dr. Vassal.

This species is easily distinguished from *S. leucopus typicus* by its darker colour above, grizzled hands and feet, and by the outer sides of the limbs being similar in colour to the rest of the upper parts. Whereas the typical *S. leucopus* is greyer, the outer sides of the limbs are buff, and the hands and feet pure yellowish white.

*SCIURUS MACCLELLANDI MARITIMUS* Bonh.

*Sciurus macclellandi maritimus* Bonh. Ann. & Mag. Nat. Hist. ser. 7, vol. iv. p. 51 (1899).

\* The reading of this paper it has been pointed out to me that the name "*fumigatus*" is preoccupied, having been used by Gray in 1867. I therefore propose to rename this squirrel *Sciurus vassali*.

a. ♂. One specimen, 10th Nov., 1905.

A single example of this Chinese race has been brought back; it resembles the type closely and in all respects. The occurrence of this form in Annam is certainly surprising; it may, however, prove to range along the whole S. Chinese coast, while *S. rodolphi* inhabits the higher ground; on the other hand it might have been brought over on a ship and escaped.

*SCIURUS MACCLELLANDI RODOLPHI* A. M.-E.

*Sciurus rodolphi* A. Milne-Edwards, Rev. et Mag. de Zool. xix. p. 227 (1867); id. Rech. Mamm. p. 162 (1871).

*Sciurus maclellandi rodolphi* A. M.-E., Bonh. Ann. & Mag. Nat. Hist. ser. 7, vol. iv. p. 54 (1899).

a-c. Three specimens.

These are very typical specimens. The light stripes are of the same width throughout, and have a tendency to a deeper and more rufous tinge on their anterior portion. The median dark stripe tends to become divided down the centre by a brownish grizzled stripe; the length and extent of this latter stripe seem to be very variable.

*FUNAMBULUS BERDMOREI* (Blyth).

*Sciurus bermorei* Blyth, J. A. S. B. xvii. p. 63 (1849); Anders. Zool. Res. p. 261 (1879).

*Funambulus bermorei* (Blyth), Bonh. P. Z. S. 1901, vol. i. p. 56.

a, b. Bali, Annam, 10th Nov., 1905.

*S. mouhoti* Gray was merely described on a seasonal form of this species, as I have already pointed out.

*FUNAMBULUS RUFIGENIS FUSCUS* Bonh.

Abstr. P. Z. S. 1907, p. 2 (Jan. 22, 1907).

Similar to *F. rufigenis typicus*, but the general tone of colour very much deeper. Colour above very dark brown, finely grizzled with buff. The whole of the thighs suffused with deep chestnut, which is not the case in the typical form. Sides of face chestnut, rather deeper in tint than in the typical form, and the same may be said of the chestnut on the under side of the tail. Remainder of under parts creamy white.

The skull appears to be of a rather stouter build, but without a good series it would be unwise to lay stress on this fact.

*Dimensions* of type (from skin). Head and body 190 mm.; tail (broken) 150; ear 12.5; hind foot 43.

*Hab.* Bali, Annam, 250 m. alt.

*Type.* B.M. 6.11.6.28. Collected by Dr. Vassal on the 10th Nov., 1905.

The much darker general colour and the rufous tinge on the outer sides of the thighs form good distinctive characters by which this species may be easily distinguished from the typical race.

*RHIZOMYS PRUINOSUS* Blyth.

*Rhizomys pruinosus* Blyth, J. A. S. B. xx. p. 519 (1851); id.

Cat. Mamm. As. Soc. Bengal, p. 122 (1863); Anders. Zool. Res. p. 325 (1879).

a. Plateau of the Lung Brau, 1300 m., 30th Oct., 1905.

This specimen is only a flat skin without a skull; Dr. Vassal notes that it is "not rare" in Annam.

*HYSTRIX YUNNANENSIS* Anders.

*Hystrix yunnanensis* Anders. Zool. Res. p. 332 (1879).

a. ♀ imm. Ninh Hoa, 25th Dec., 1905.

This is a very young specimen, but has a well-developed nuchal crest. The skull in its general proportions agrees with Dr. Anderson's description. The external characters, however, agree well with Swinhoe's *H. subcristata*, and, in fact, the only difference between these two species is to be found in the skulls. In his original description Swinhoe states that the skull of *H. subcristata* is indistinguishable from that of *H. hodgsoni* Gray, which, of course, is quite distinct from Anderson's species. Unfortunately there are no specimens from China in the British Museum which would enable us to determine definitely whether there be two Crested Porcupines in China, or whether Anderson's and Swinhoe's species are in reality one and the same.

*LEPUS VASSALI* THOS.

*Lepus vassali* Thos. Ann. & Mag. Nat. Hist. ser. 7, vol. xvii. p. 425 (1906).

a. ♀. Nha-trang, Annam, 25th Dec., 1905.

Mr. Thomas having recently described this specimen, I need only refer those interested to the paper quoted above.

*TRAGULUS KANCHIL AFFINIS* Gray.

*Tragulus affinis* Gray, P. Z. S. 1861, p. 138.

*Tragulus kanchil pierreii* Bonh. Ann. & Mag. Nat. Hist. ser. 7, vol. xi. p. 293 (1903, 1st March).

a-c. ♂. Nha-trang, 22nd March, 1906.

These specimens agree in all respects with my description of *T. k. pierreii* quoted above. I have used Gray's name for this species in preference to my own, as Mr. Miller has pointed out to me that Gray's *T. affinis* was chiefly based on specimens from Cochin China; and Mr. Miller having, previously to my paper, described the Peninsula form under the name *T. rarus*, Gray's *T. affinis* became *ipso facto* restricted to the race from Cochin China: with this finding I quite agree.

*MANIS JAVANICA*.

*Manis javanica* Desm. Mamm. p. 377 (1820); Anders. Zool. Res. p. 352 (1879).

a. Dang-trang, near Nha-trang, 25th Dec., 1905.

#### EXPLANATION OF PLATE II.

*Nycticebus pygmaeus*, p. 1.

2. On the "Bleating" or "Drumming" of the Snipe  
(*Gallinago caelestis*). By P. H. BARR, B.A., F.Z.S.

[Received November 20, 1906.]

(Text-figures 3-9.)

This subject has been much discussed, but the interest taken in it seems rather to have waned during the latter years. I think therefore it would be profitable to inquire once more into this strange phenomenon, especially as many points require elucidation, in the explanation of which authorities differ considerably. I believe it is well known to all of us that during the breeding-season our Common Snipe performs certain aerial evolutions, producing at the same time a mysterious sound, called in various parts of the country bleating, humming, drumming, or whirring, "Meckern" in Germany, while in parts of Scotland the popular name of the bird is "Heather Bleater," and in France "Chèvre volant." The process is shortly as follows:—The bird is seen to fly straight up to a height of from 60–100 feet, then, turning, to spread its tail, close its wings, and drop to within 20–30 feet of the ground, producing at the same time this mysterious sound, which has puzzled observers so. As to the cause of it many theories have been put forward by scientific ornithologists, sportsmen, and foresters. We may group the evidence for these theories under four heads:—

- I. The sound is produced by the vocal organs.
- II. The sound is produced by the rectrices of the tail, which I hope to be able to prove is correct.
- III. The sound is produced by the action of the primaries of the wing.
- IV. The sound is produced by the combined action of the wings and tail (maintained by a few observers).

I. The first evidence in favour of this theory which I can find is an article by Dobel ('Jäger Practica,' 1783, pt. i. p. 73), who says that the Snipe produces at night-time, while sitting *on the ground* in a marsh or close to water, a noise which the ignorant would mistake for the bleating of a young goat.

Bechstein, in 1789 (Naturgesch. Deutsch. 2nd ed. vol. iv. p. 190), maintains "that the Snipe makes its plaintive cry, like a goat bleating, with its *beak* and not, as has been lately affirmed, with its wings." He adduces evidence of birds bleating whilst perched on the tops of trees.

Hintz ('Naumannia,' 1854, p. 290), from observations made from 1816–19, believes the sound is made by the bill. He heard Snipe "bleating" *whilst sitting* on top of withered oak-trees, first uttering their call-note "pecka pecka," and then bleating.

Zöppritz (Ornith. Centralblatt, Nov. 1880) seems to be very certain of the accuracy of his observation, for he writes:—"Two years ago I published an article on this subject in a sporting journal, wherein I offered to pay a fine of 500 marks to the treasury of the Allgemeine Deutsche Jagd-schutz-verein if three umpires appointed by the Verein publicly declared that they were convinced

that Snipe produced their bleating notes, not through the vocal organs, but by means of their wings, with or without help of their tail-feathers." Nobody seems to have accepted the offer, and we understand Herr Zöppritz kept his 500 marks. Again, we find in the same paper:—"Anyone with a knowledge of mechanics or physics, if he sufficiently examine a dead Snipe, must be convinced that so small a bird, with wing- and tail-feathers so comparatively weak, cannot possibly produce sounds with them, which are at such a distance so sharply accentuated. Hence I indulge the hope that the adherents of the wing and tail theories will now withdraw their opinions and acknowledge that to err is human."

Lastly, in Seebohm's 'British Birds,' vol. iii. p. 244 (1885), we find the following:—"I have listened to the drumming of the Snipe scores of times with the express purpose of discovering the mode in which the sound is produced, but must confess myself completely puzzled. Arguing from analogy, I should say it was produced by the *vocal organs*, and is analogous to the trill of the Stints and other Sandpipers. The fact that it appears to begin the instant the bird begins to descend induces me to think that, after allowance is made for the time it takes for sound to travel, it must really begin before the descent, whilst the bird is not moving very rapidly."

Of such is the evidence with which we have to deal. At the present day I trust this theory has but few adherents. Pralle seems to have disposed of it entirely by a note recorded in 'Naumannia' (1852, pt. i. p. 25), that on 24th March, 1846, he heard the Snipe utter its note, "gick-jack, gick-jack," while bleating.

II. That such a sound could be produced by such feeble instruments as the rectrices seems to have been foreshadowed by Naumann, curiously enough by a misprint of the word "tail" for "wing-feathers" ('*Federwild-jagd*,' von Louis Liegler, Hannover, 1846, p. 174):—"It is not hard with sharp eyes (still more with field-glasses) to observe the quivering motion of the tips of the *tail-feathers* [the italics are my own] during each downward and upward flight through the air, sufficient to convince one that the sound is thus produced, and not from the throat of the bird. The sound, or at least a similar one, can be produced if one take the primaries of certain (but not too small) birds and fasten them to the end of a long cane, and strikes with this, as with a sword, in a draught of air."

To which Jäckel ('*Naumannia*,' 1855, pp. 112, 113) replies and casts doubt on Naumann's theory (or, rather, mistake) of the sound being produced by tail-feathers.

In 1858 Mr. Wolley communicated a paper by Mr. Meves, of Stockholm (Proc. Zool. Soc. Lond., April 1858, p. 199), wherein Mr. Meves, in consequence of the misprint already quoted, was led in 1856 to make experiments with the rectrices of *G. coelestis*.

He remarked with surprise "that the humming sound could never be produced whilst the bird was flying upwards, at which time the tail is closed; but only when it was casting itself downwards in a slanting direction, with the tail strongly spread out."



He then examined the tail-feathers of our common species more closely and found "the *first* (outer feather) especially very peculiarly constructed; the shaft uncommonly stiff, sabre-shaped. The rays of the web strongly bound together and very long, the longest reaching nearly  $\frac{1}{2}$  of the whole length of the web, . . . like the strings of a musical instrument. If one blows from the outer side upon the broad web it comes into vibration, and a sound is heard, which, though fainter, resembles very closely the well-known neigh." He then fastened the outer or first feather with fine thread to a piece of steel wire and fixed it to a 4-foot stick, and found if he drew this with the outer edge of the feather through the air, at the same time making shaking motions of the arm to represent the shivering of the wings during flight, he was able to produce the neighing sound with astonishing exactness. In bringing the matter before the Zoological Society Mr. Wolley confirmed Meves's experiments. These experiments I hope to explain more fully anon.

John Hancock, in 1875, in the 'Birds of Northumberland and Durham,' vol. vi. pp. 105-113, severely criticises Meves's theory and experiments.

I cannot quote his article at length, for it is a very long one. He argues, from the diversity of structure exhibited by the rectrices of various species of Snipe, that they cannot be musical instruments. He failed to produce the neighing sound of a Snipe by Meves's experiment, but admits "when the web of almost any firm feather is blown upon a low vibrating sound is produced: and such a sound is stronger when a tail-feather of the Common Snipe is used, arising apparently from the fact that the inner web is wide and firm; but the sound is so low that it cannot be heard many yards off."

Later: "The sound is audible at a great distance, even when the bird has risen high into the air. No sound that could be produced under any circumstances by such feeble instruments as the lateral tail-feathers of the Snipe, instruments not larger than the wings of a Dragonfly, could be heard at any considerable distance. And it is scarcely to be doubted by anyone that the wings of a Snipe vibrating rapidly will produce some sound louder than any that could be made by a pair of small tail-feathers of a bird rushing downward through the air."

Prof. Altum ('Ornithologisches Centralblatt,' Oct. 1880) satisfied himself that he could produce the sound with the lateral tail-feathers. He, however, quotes "two adverse cases":

- (1) A Snipe was observed "bleating" as it sat, or rather stood, on an elevation.
- (2) A certain Alex Schmidt winged a Snipe which, with tail stiffly expanded, began to bleat in his hand, the air blowing through the web of the feathers, the wings being held close to the bird's side. Every time the bird was moved rapidly against the wind his object was attained.

It is to be noted that in both cases a *strong wind* was noticed to be blowing. That these two cases are easily explicable I hope to adduce evidence later on.

In answer to this paper, von Zöppritz (Ornith. Centralblatt, Nov. 1880) disputes Altum's tail-theory, giving four reasons, which I will not here quote\*.

III. The wing-theory has had the greatest number of adherents.

Macgillivray in 1840 ('British Birds,' vol. iv. p. 372) expresses his conviction that this is the case. Sir Wm. Jardine, in the 'Naturalist's Library' (vol. xxvi. Ornithology, p. 180), says: "The sound is never heard, except in the downward flight, and when the wings are in rapid and quivering motion. Their resistance to the air without doubt causes the noise. Dr. Saxby ('Birds of Shetland,' p. 204) expresses his conviction that 'drumming is produced by the vibrations of the wings alone.'"

Naumann, in the article already quoted, and Zöppritz (Ornith. Centralblatt, Nov. 1880) wrote in favour of it in Germany.

John Hancock, whom I have already quoted, agrees in the main with what Mr. J. E. Harting ('Essays on Sport and Natural History,' pp. 284 *et seq.*) has written:—"From the peculiar vibration of the wings in the downward descent of the bird, it would appear that the primaries, instead of firmly overlapping each other, are, in the act of humming, turned broadside in the air, which is thus able to play across the inner web of each, and so to impart to each a vibratory motion and consequent sound—faint indeed in the case of a single feather, but audible enough when an entire wing is acted upon. Whether this be the true explanation of the singular sound, it is, of course, not easy to prove conclusively; but it has certainly been accepted as such by many naturalists in England, who are the more inclined to adopt this view from having observed Peewits, Rooks, Gulls, and other birds, with tails very different from that of a Snipe, make an analogous sound while falling through the air." That Mr. Harting was partially successful in producing the bleat artificially is evident, for he has "succeeded beyond expectation in producing a sound like the 'humming' of the Snipe." Again: "But any of the primary wing-feathers will give forth a faint sound, which may be increased in proportion to the number of them passed through the air at once." But he finds that the tail-feathers when fastened into a switch do not occupy the position they do naturally in the bird's tail, because they are drawn through the air at right angles to the direction of flight, "in a position which is occupied naturally by the primaries, but unnaturally by the tail, and hence it must be the primaries (collectively) which produce the sound in nature. In this our sense of hearing is assisted by the sense of sight, for a perceptible vibration of the quill-feathers is observed every time the bird descends."

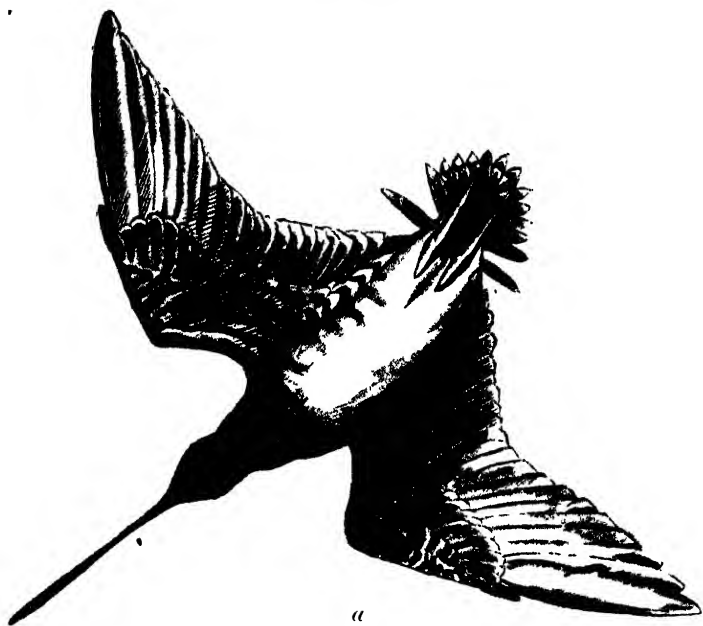
IV. Two observers maintain that the sound is produced by the agency of both the wing- and tail-feathers.

H. Gadumer ('Naumannia,' 1853, pp. 411-413) watched a bird

\* [Mr. F. W. Headley ('Nature,' vol. lxx. p. 103, 1904) supported the theory that the drumming was produced by the outermost tail-feathers, and adduced an experiment by which the sound could be produced artificially.]—ED. P. Z. S.

bleating, with a good field-glass. "The air pressing between the wings and the tail (a natural parachute) causes all the feathers of the tail and wings to vibrate and gives rise to the bleating sound — which is modified by stronger or weaker vibrations."

Text-fig. 3.



*a.* Snipe bleating, showing characteristic position.  
*b.* Formation of tail as ordinarily held in flight.

Capt. W. V. Legge, in his appendix to the 'Birds of Ceylon,' expresses the opinion that the sound is produced by the combined action of the wings and tail.

I have dwelt on the literature for some length, in order that one may review the evidence adduced by the adherents of the different theories.

In the summer of 1904, in the Fens of Cambridgeshire, I began to observe the Snipe in the act of bleating through a strong prism binocular. I had read none of the literature on the subject, and so had no preconceived ideas. The observations I made then I have had ample opportunities of confirming.

I find that ordinarily the bird flies up to a height of 60-100 feet above ground, in windy weather going higher, with its tail held in the ordinary position of flight (text-fig. 3, *b*), then, turning, it spreads its tail out like a fan, *the two outer tail-feathers* being spread out well in front of the other twelve and held firmly there (text-fig. 3, *a*). Immediately the bird begins to descend the bleat is heard (making due allowance for the time it takes for sound to travel). While descending the bird makes tremulous motions with its wings from the radio-carpal joint. The descent is made from 30-40 feet and occupies 2-3 secs., the bleat lasting the same time. The bird does not drop head foremost through space, but at an angle of from 45°-60° with the horizon. The tail as a whole is not vibrated, but it is quite easy to see the two outer tail-feathers with a strong glass vibrating to such an extent that their terminal portions become indistinguishable. Snipe begin to bleat in March, but if the weather is mild, in February, and continue to the end of May, though I heard one last year in Sutherland still bleating on June 25th.

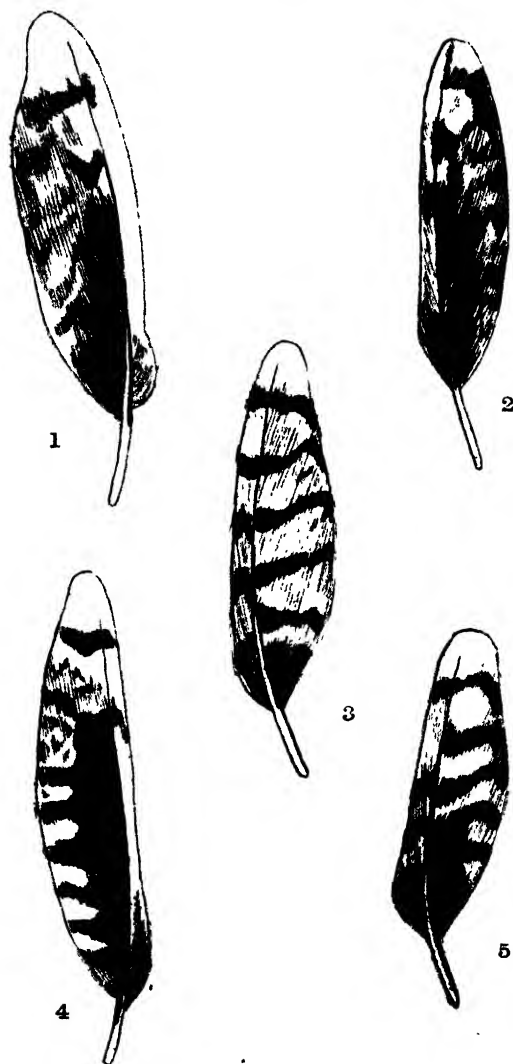
At the beginning of the breeding-season they may be seen bleating in pairs; but later on, when the hen is sitting, the cock bird may be seen performing alone over the marsh where the nest is placed. Under favourable conditions many bleat together, circling round the same spot for hours. On April 12th of last year, I had the good fortune to hear no less than twelve birds bleating together, a concert which they kept up all through the night. Every now and again, as if by common consent, there would be a lull, and all the birds would settle, but directly one began again all the rest immediately joined in the chorus.

Snipe bleat best in the early morning and in the evening, especially when the weather is dull and damp. It may be of interest to note that last spring I saw a specimen of the melanistic variety (Sabine's Snipe) bleating.

Once having convinced myself that the two outer tail-feathers are invariably spread out beyond the others, a fact which is now obvious to me with the unaided eye, it seemed to me that the two outer tail-feathers must be the active agents in causing the bleat. I accordingly procured several tails of the Common Snipe, and taking the two outer tail-feathers, pierced the shaft with a pin,

to which I firmly bound it with cotton and inserted the feathers into a cork at the end of a stick some six inches long. A hole is bored at the other end of the stick and a long string attached. This is whirled round the observer's head and a typical bleat is produced. The second outer tail-feathers (sixth pair) produce a fainter sound, though this varies much in individual tails, the others make no sound at all.

Text-fig. 4.

Varieties of outer tail-feathers of *Gallinago caelestis*. (Natural size.)

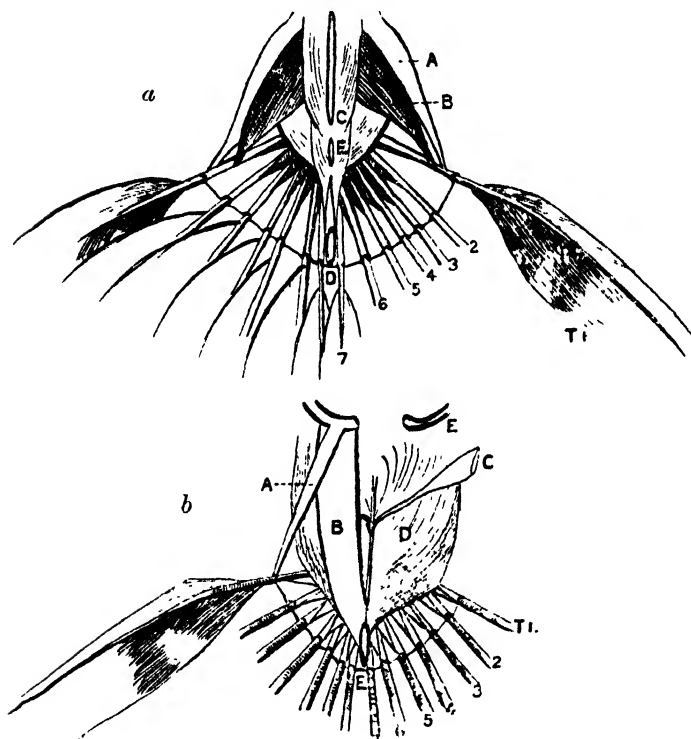
In order to ensure the success of the experiment it is necessary (1) that the feathers be placed so that the narrow edge, the outer web, shall encounter the resistance of the air; (2) that the feather be firmly bound to the pin, so that it cannot turn on its support; (3) that the string be tied to one end of the stick, so that the long axis of the stick makes an angle with the direction of the string, if I may so put it, so that a vibratory motion is imparted to the stick as a whole, thus simulating the tremulous motion of the Snipe's wings during the descent; (4) lastly, that the apparatus be moved at a uniform rate and not too fast.

It is then found that after a period of silence the feathers begin to vibrate: first, the long-drawn-out note, which I may represent as "whŭ wh ŭ ŭ n," becomes gradually audible, it is then succeeded by a series of high and low notes "bāh-bāh-āh-āh," resembling the bleat of a young goat, lasting 3-5 secs., followed by a *pause of equal length*. This is repeated as long as the apparatus is revolving at a uniform rate. It is found that the individual tail-feathers, of which I collected a good number during the winter, vary considerably both in size, breadth, and markings, and, as might be expected, the note produced varies according to their physical characteristics. Thus a long narrow feather produces a sound of far higher pitch than a broader one of the same length (*vide* text-fig. 4). This fact I have noted when comparing the sound made by several birds when performing the nuptial evolutions over their breeding-grounds. To ascertain which part of the feather is essential in the production of the sound, I have cut off the narrow outer web, without altering the bleat in any way; but if the barbs of the inner web be so disarranged that there is a break in their continuity, the web ceases to vibrate, and no sound is produced. That the vibration of the inner web is the active causative agent may be seen by the following simple experiments:—The feathers are attached to a cork, with the outer web held away from the observer, so that the narrow outer web shall cleave the resistance of the air. Thus affixed they are held out of the window of a train, or while riding a bicycle. As the resistance of the air is encountered the inner web begins to vibrate, slowly at first, but as the train gains speed, so rapidly that its outline is entirely lost, and it becomes a blur; a low humming sound is at first heard, which soon reaches the typical pitch of the bleat. When the train has reached the speed of some 20 miles an hour, the whole feather will vibrate on the pin. If the feathers are at all loose on their pins it is curious to observe how they will always turn round so that the narrow outer edge encounters the resistance of the air. Furthermore, if the feathers be damped, they appear to act better, thus explaining, perhaps, why Snipe are found to be liable to bleat in damp weather. I think this simple experiment readily explains away the "adverse cases" of Prof. Altum ('Ornithologisches Centralblatt,' Oct. 1880) already mentioned.

That the hens bleat as well as the cocks is now, I suppose, a well-known fact (*cf.* von Preen, 'Naumannia,' 1856, pp. 426, 427,

and Meves, Proc. Zool. Soc. 1858, p. 200). I have observed it on several occasions myself. In the summer of 1902 I found four newly hatched Snipe in a patch inhabited by only a single pair; while lying concealed in the neighbourhood I observed repeatedly *both* old birds drumming above me. From the similarity of

Text-fig. 5.



a. Dorsal view of musculature of tail of Snipe.

A=slip of m. ilio-coccygeus to outer  
rectrix.

B=m. ilio-coccygeus.

C=levator coccygis.

D=pygostyle.

E=fused spines of caudal vertebrae

b. Ventral view of musculature of tail of Snipe.

A=m. pubococcygeus ext.

B=m. pubococcygeus.

C=m. caud. ilio-femoralis.

D=depressor coccygis.

E=pygostyle.

structure of the tail-feathers in both sexes, a fact which I have ascertained by dissection, one would infer that both sexes drummed. I cannot, however, agree with Meves that "as the feathers of the hen are generally less than those of the cock bird, the noise also made by them is not so deep as in the other case"

(*op. cit.* p. 200). I can find no difference either in the length of the feathers or in the intensity of the sound produced by the feathers of either sex. I have received a letter from Mr. S. A. Buturlin, in which he says that in 1905, on the Kolyma Delta, he frequently observed both sexes of the eastern representative of our species (*Gallinago raddii*) drumming.

Since the two outer feathers are extended beyond the other twelve during the descent, as I have described, I sought to find by dissection a mechanism by which this might be produced. On examining the tail of a freshly-killed bird, it is quite easy, by spreading out the tail, to make it assume the arrangement shown (text-fig. 3). I was unable, however, to find any special muscle peculiar to the species controlling the outer two tail-feathers. The muscle pubococcygeus ext. (text-fig. 5, *b*) is inserted into the base of the shaft of the outer two tail-feathers, and is quite capable of performing this function. This muscle is to be found equally well developed in the other species of Plovers and Waders which I examined. The nomenclature of the muscular system of the tail is that of Gadow in Bronn's 'Thier-Reich.'

I have tried the same experiments as I have just described with the primaries from the wing of the Snipe, and was not able to produce any more sound with them than with others taken from other kinds of Waders, Pigeons, &c. There seems to have existed an opinion at one time that the bird produces two sounds, one with the wings and the other with the tail, the former being known as humming or drumming, and the latter whirring or bleating, produced while the bird is on the ground (*cf.* 'Zoologist,' 1881, p. 212, and 1846, p. 1501). I cannot say that this agrees with my own experiences.

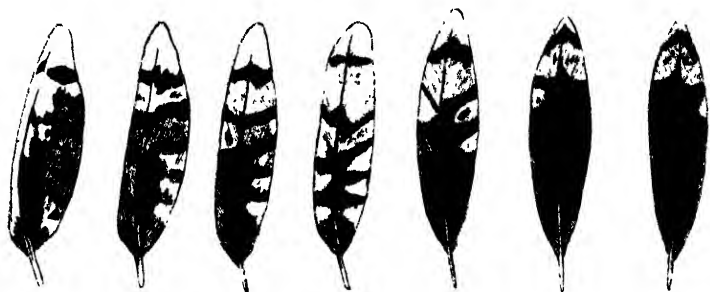
*An Examination of the Structure of the Tail of Gallinago crelestis*  
(text-figs. 6, A, and 7).

The normal number of feathers in the tail of this species is 14. It could hardly fail to strike the observer, on examining the tail, that the outer two differ considerably from the rest. Firstly, they are lighter in colour and their texture is firmer. On closer examination the shaft is seen to be strong and firm, presenting a decided outward curve towards its lower third. The outer web is narrow, and formed of stiff rami, which can easily be separated. The *inner web*, on the other hand, is extremely broad, being six times as broad as the outer, and formed of long stiff rami, of which some reach quite three-fourths the whole length of the feather, making a very acute angle at their insertion with the stem (text-fig. 6). The individual rami adhere firmly to one another, and can with difficulty be separated. These are provided with two well-developed rows of radii, the distal and the proximal rows (text-fig. 7, B), the former are twice the length of the latter. I must here express my great indebtedness to Mr. W. P. Pycraft, who has allowed me to make full use of his excellent paper, on

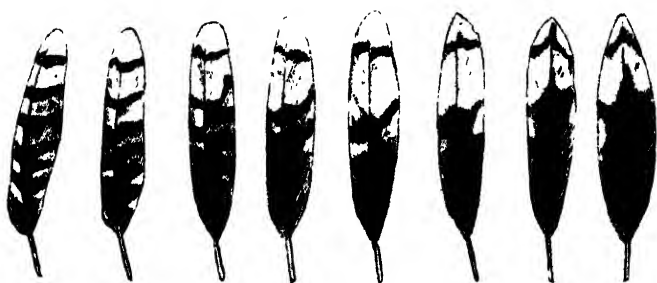


"The Interlocking of the Barbs of Feathers" ('Natural Science,' vol. iii. No. 19, Sept. 1893), and from which the illustration (text-fig. 7, A) is copied. Under the microscope the distal row is seen

Text-fig. 6.



A



B

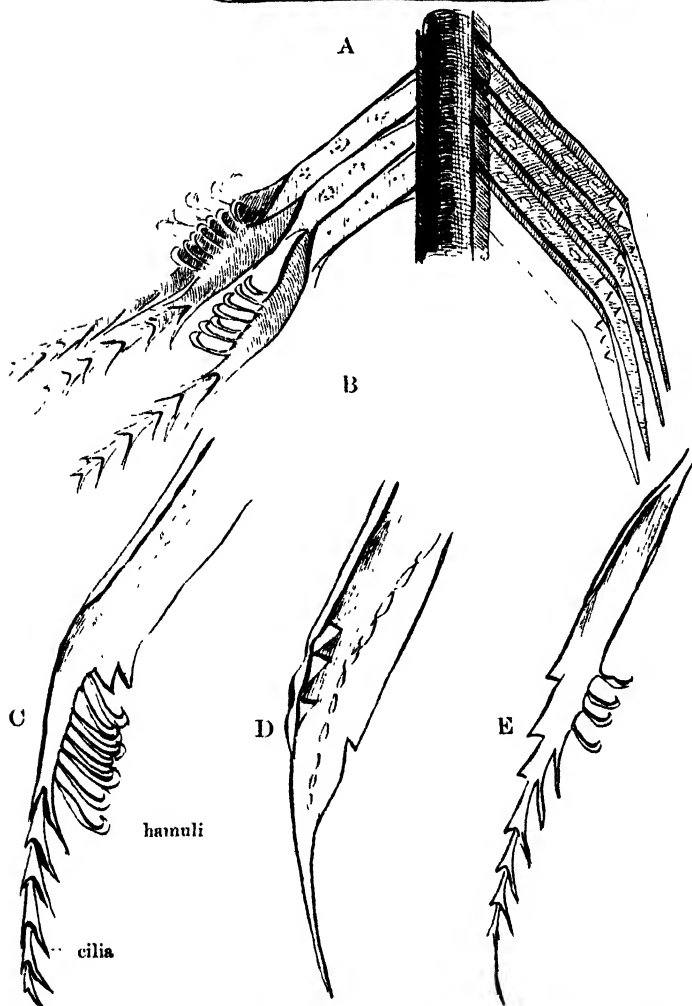


C

- A. Half of tail of *Gallinago caelestis* from without inwards left to right.  
 B. Half of tail of *G. delicata* from without inwards left to right.  
 C. Half of tail of *G. gallinula*.

to be well provided with hamuli and cilia (text-fig. 7, B). The hamuli deserve attention (text-fig. 7, C), since I believe them to

Text-fig. 7.



- A. Section of two rami of a feather showing interlocking of distal and proximal radii. (After W. P. Pycraft.)  
 B. Ramus of *Gallinago caelestis*, showing proximal and distal rows of radii.  
 C. Distal radius of *G. caelestis*. D. Proximal radius  
 E. Distal radius of middle tail-feathers of *G. caelestis*.

be the essential factor in producing the bleat, in that they hold the stiff rami together like the strings of a harp. They are seven or eight in number, a number in excess of any other species of Snipe, and are well-formed, possessing a well-hooked terminal portion, which interlocks with the upturned edge of the radii of the proximal row (text-fig. 7, A & D). The outer web is formed of stiff rami, which possess rudimentary radii unprovided with hooklets.

Of the remaining feathers, the sixth pair most nearly approaches our type feather in structure (text-fig. 6, A). The shaft is, however, not so strong, the outer web is broader, the inner narrower, and the rami are not so long, nor do they form such an acute angle with the stem (text-fig. 6, A). The hamuli are five in number and not so well-formed, and, as I have said before, the sound produced by the vibration of the inner web of these feathers cannot compare in intensity with that produced by the outer pair. Thus the outer web becomes gradually broader, the inner gradually narrower as we reach the central tail-feathers (text-fig. 6, A), and the rami become progressively weaker, the hamuli fewer in number. Thus the distal radius of the middle tail-feathers possesses but four feebly curved hamuli (text-fig. 7, E).

I have examined the tail of this species during the moult. On the 17th of August, 1906, I received several from Scotland, just at the beginning of the moult. The outer tail-feathers, I find, have lost much of their bleating power and the note produced is not so intense. On microscopical examination I find the cilia (text-fig. 7, C) have all been worn away. From this I infer that the cilia play a certain part in the production of the sound. From the 17th August to the 6th September I received many tails in which the new feathers were just growing, and I find that in every case the outer tail-feather (the sonorous instrument) is the last to be assumed. The newly assumed feather possesses full bleating powers. I have also examined feathers from young birds of the year directly they have assumed their full plumage; these, I find, will bleat as well as those of a fully adult bird, and possess the normal structure and characteristic number of hamuli.

One variety of *G. caelestis* still remains to be mentioned, i. e. *Gallinago raddii* (Buturlin), which is the eastern representative of our species and is much lighter in colour. With characteristic kindness, Mr. Buturlin has sent me skins of this and several other species from the Kolyma Delta in Siberia (69° 4' 20" N. and 160° 55' E.), accompanied by most valuable notes, for which I am deeply indebted. The feathers of the tail, of which I have figured a specimen (text-fig. 4, 4), behave in the same way as those of our species.

#### *Examination of the Tail of other Species of Gallinago.*

*Gallinago delicata*, or Wilson's Snipe, of N. America, differs in the eyes of some materially from *G. caelestis* in possessing

sixteen tail-feathers. Of these the outer two are specialised, but differ from those of *G. caelestis* in that the inner web of these feathers instead of being broader is narrower than that of the other (text-fig. 6, B); they are, in fact, somewhat attenuated—a process which, as we shall see later, reaches its extreme in the Pin-tailed Snipe (*G. stenura*) of India. The shaft is strong, but not so strong as that of our species. The inner web is three times as broad as the outer. Both feathers will produce a bleat on experiment; the sound is of a far higher pitch than that of *G. caelestis*, as might be inferred from the character of the feathers, and is what is aptly described by the Americans as "winnowing." The rami are shorter in comparison with *G. caelestis*, and make an acute angle with the shaft. The radii of the outer web are rudimentary, of the inner web the distal is but one-third longer than the proximal row; the hamuli are five in number, but are not so well hooked as those of *G. caelestis*. Of the two, the outer or eighth is more attenuated than the seventh pair.

Regarding the habits of this species I have the following references:—

Baird, Brewer, and Ridgway, 'Water-Birds of N. America,' vol. i. p. 191:—"Capt. Blakiston noticed that this species performed the same evolutions as the European bird, this usually about sunset, but at times continuing  $1\frac{1}{2}$  hours later. The noise made on these occasions he compares to rapidly repeated switches of a cane in the air, and this was repeated every half minute with occasional longer intervals. The sound lasted about three seconds, and was made as the bird descended rapidly in a vertical direction, being caused apparently by the quill-feathers of the wings. This sometimes took place in the middle of the day, but only during the love season."

Again:—

Audubon, 'Birds of America,' p. 343:—"These birds are often met with in meadows, or on low grounds, and by being on the spot before sunrise, you may see *both* mount high in the air in a spiral manner, now with continuous beats of the wings, now in short sailings, until more than a *hundred yards* high, when they whirl round each other with extreme velocity and dance as it were to their own music, for at this juncture, during the space of 5 or 6 minutes, you hear trolling notes mingling together, each more or less distinct, perhaps according to the state of the atmosphere. The sounds produced are extremely pleasing, though they fall faintly on the ear, but I am well assured that they are not produced simply by the beatings of the wings, as at this time the wings are not flapped, but are used in sailing swiftly in a circle not many feet in diameter. A person might cause a sound somewhat similar by blowing rapidly alternately from one end to another across a set of small pipes consisting of 2 or 3 modulations."

From this we gather that this species performs its evolutions at

a greater elevation than our species, also that Audubon noticed the fact that both cock and hen bleat.

William Brewster, in Chapman's 'Handbook of Birds of North America,' writes, pp. 154-155:—"In the springtime, and occasionally in autumn also, Wilson's Snipe mounts to a considerable height above his favourite meadows, and darts downward with great velocity, making at each descent a low yet penetrating tremulous sound, which suggests the winnowing of a domestic Pigeon's wings, and if heard at a distance, the bleating of a goat, and which is thought to be produced by the rushing of the air through the wings of the Snipe. This performance may be sometimes witnessed in broad daylight, when the weather is stormy, but ordinarily it is reserved for the morning or evening twilight or for moonlight nights, when it is often kept up for hours in succession."

Other American species deserve mention here:—

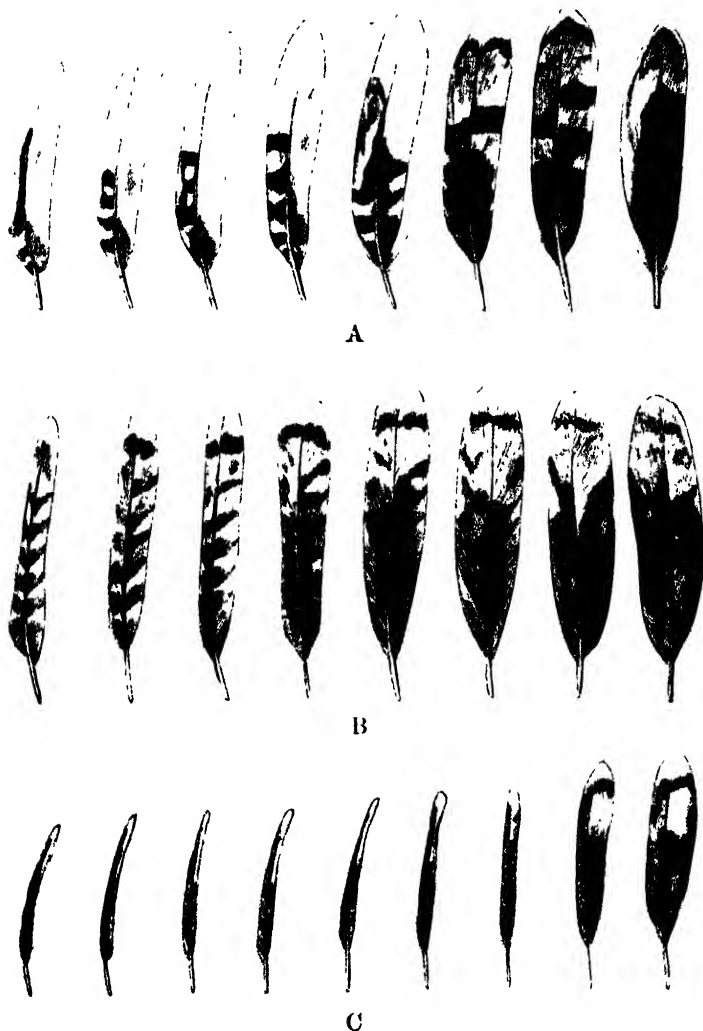
*Gallinago nobilis* (text-fig. 8, B) has 16 tail-feathers, of which the outer three are attenuated and the fourth partially so. It inhabits Ecuador and Colombia, and is allied to *G. australis*, which species I shall treat of later. I can find no reference to the breeding-habits of this species. On experiment the three outer feathers bleat well. As in *G. delicata* the rami of the outer web possess but rudimentary radii; those of the inner, however, possess a distal row which is one-third longer than the proximal, and the former is provided with five hamuli which are not well-hooked. The rami are thicker and stiffer than in the aforementioned species, and I suspect it is more by the vibration of the rami as a whole that the sound is produced, in contradistinction to the vibration of the inner web alone as in *G. celestis* and *delicata*. The inner web of the eighth pair is but little broader than the outer, but that of the seventh pair is nearly twice as broad, thus resembling the outer tail-feathers of *G. delicata*. The middle tail-feathers conform to the ordinary type. The sound produced is hard to describe; it is flute-like, but possesses a definite bleating character.

*Gallinago frenata*.—Another South American species inhabiting Brazil, believed to be a Neotropical form of *G. delicata*. This species has 16 tail-feathers, of which the outer four are attenuated, the outermost being one-fifth inch in diameter, the inner being but slightly wider than the outer web. The inner web becomes progressively larger towards the centre of the tail. This species agrees with the foregoing in having the specialised feathers of a lighter colour: all four bleat; this is similar to that of *G. nobilis*, but shriller: microscopically they resemble the structure of *G. delicata*. The distal radii of the inner web are one-third longer than the proximal row and possess five well-curved hamuli. The rami of the outer web are stiff and structureless.

*G. paraguayae* is a subspecies of *G. frenata* inhabiting Paraguay. It is much larger than the type, and the tail-feathers are

consequently larger and the bleat deeper in tone ; otherwise they agree in number and structure. A description of the breeding-

Text-fig. 8.



- A. Half of tail of *Gallinago major* from without inwards left to right.  
 B. Half of tail of *G. nobilis* from without inwards left to right.  
 C. Half of tail of *G. stenura*.

habits of this species is to be found in a paper by Durnford in the 'Ibis,' 1877, p. 198 :—"During the spring they go through the

same aerial movements as the Common Snipe at home, rising to a great height by a circling motion, and 'drumming' whilst descending in a diagonal line. How is this curious habit to be accounted for in the South-American and European forms, except by the theory of inheritance from a common progenitor?"

*Gallinago australis*.—Latham's Snipe has 18 tail-feathers, of which the outer three are attenuated, two being less than  $\frac{1}{2}$  of an inch in diameter; the outer six, however, are doubtlessly specialised, as they differ markedly from feathers from the centre of the tail both in structure and colour. The feathers bear a certain resemblance to those of the South-American species. The shaft is thick and curved; the rami of the inner web are long and thick, but more easily separated than in the latter species. The rami are peculiar, in that they are thicker and stiffer than in any other species. The distal rami of the inner web are longer than the proximal row and are provided with 5 hamuli. The rami of the outer web are stiff and structureless, thus resembling *G. caelestis*, *paraguayae*, and *frenata*. The feathers produce a loud bleat, somewhat similar to that of *G. caelestis*.

I have received from Mr. Alan Owston, of Yokohama, a skin of this species, accompanied by some very valuable notes, which add materially to our knowledge of the habits of this species, for which I am greatly indebted to that gentleman. He says: "They breed on the grassy moorland at the foot of Mt. Fugiyama, at an elevation of 2000–3000 ft. above the sea (Fugiyama is 12,500 ft. high). I have watched them on the 28th April, and on other dates during the breeding-season. When alarmed they fly round overhead, circling round generally against the sun, and every now and again they begin to cry 'chip, chip, chip, sheep, cheo, cheo, cheo,' and then rush downwards at the intruder, beating the air in the descent and making a terrific rushing noise."

He also sends me an extract from Capt. T. W. Blakiston's notes on the breeding habits of this species published in the 'Chrysanthemum' for Nov. 1882, p. 524 *et seq.*, referring to "Birds observed on the S.E. coast of Yezo in May":—"The Australian species act very like the Snipe of North America, by flying round pretty high and making sudden rapid descents almost to the ground, which latter movement is accompanied by a whispering noise. At evening and during the day in dull weather, these evolutions are commonly performed; and in dirty rainy weather the noise is heard even in the middle of the night."

*Gallinago aucklandica*.—Resembles *G. australis* in having 18 tail-feathers, the outer three of which are attenuated; they are, however, much softer in structure than in that species. The rami of the inner web are easily separated, and possess 4 hamuli; those of the outer are provided with rudimentary rows of radii, thus approximating to certain Asiatic members of the genus. I have received a specimen of this rare species from the Christchurch Museum, N.Z. No mention of any bleating-habits is made in

the literature. Contrary to what one would expect from its peculiar Rail-like appearance, the tail-feathers produce a very distinct and pleasing sound of a high-pitched character, somewhat resembling that of certain Asiatic species.

*Gallinago æquatorialis (nigripennis)* is an inhabitant of Central Africa, south and east of the great desert. It possesses 14 tail-feathers, of which the outer four are attenuated, and are less than  $\frac{1}{2}$  inch in diameter; they are pure white. This form is nearly allied to the Common Snipe. I have been quite unable to procure either any feathers or a skin of this species.

Its habits are described in Reichenow's 'Vögel Afrikas,' Band i. p. 236 :—"This bird is called Spook Vogel by the Boers, on account of its drumming cry, which the bird makes in the morning and evening during its flight."

*Gallinago gallinula*.—The Jack Snipe has 12 tail-feathers, of which the outer three are markedly shorter than the three central ones (text-fig. 6, C).

Their texture is soft and the rami are easily separated, in contradistinction to those of the species we have already considered. On experiment these feathers produced no sound at all.

The structure of the outer web of the outer feathers more nearly approaches that of the inner—a marked difference to that found in the other feathers we have been considering; that is, the rami of the outer web are provided with distal and proximal rows of radii and thus adhere together. The distal radii are provided with 4 hamuli both in the outer and inner webs.

The breeding-habits of this species were described originally by Wolley in Hewitson's 'Eggs of British Birds,' vol. ii. p. 356 :—"It was on the 17th June, 1853, in the great marsh of Muonio-niska (Finland), that I first heard the Jack Snipe, though at that time I could not guess what it was— an extraordinary sound, unlike anything I had heard before; I could not tell from which direction it came, and it filled me with a curious surprise. My Finnish interpreter thought it was a Capercally, and at that time I could not contradict him. I know not better to describe the noise than by likening it to the cantering of a horse in the distance, over a hard hollow road, it came in fours with a cadence, a clear yet hollow sound; it was not long afterwards that I ascertained the remarkable hammering noise in the air was made by the Jack Snipe."

Mr. S. A. Buturlin, in sending me a specimen of this species, with characteristic kindness writes the following notes of its habits as observed on the Kolyma Delta :—"Its drumming is exceedingly like the noise of a cantering horse on a hard road, as so well described by one of the best field-observers—the late John Wolley. I heard it every day in the summer of 1905, when on the Kolyma. The bird usually flies so high, that even with the aid of the midnight sun and good Zeiss binoculars it is often quite



invisible; nevertheless the sound 'top-toppy-top-toppy' is quite clearly heard."

I might also mention here that the remarkable sound produced by the Wood-Sandpiper (*Totanus glareola*) was found by Mr. Buturlin to be vocal. He shot a score of them "drumming" while sitting on a branch of *Ulmus incana*, or some local *Salix*, on the Kolyma, and has observed them for a long time at the distance of a few yards. The male flies about in wide circles, beating his wings, now floating on outstretched wings uttering as loud but not such hollow notes as the Jack Snipe.

I can only say at present that, in view of the failure to produce the drumming of the Jack Snipe artificially, I suspect there must be some other mechanism by which the sound is produced.

*Gallinago major*: "The Great Snipe" (text-fig. 8, A).—This species has 16 tail-feathers, of which the outer four are white. They are somewhat shorter than the feathers from the centre of the tail, which are similar in all species of *Gallinago*. The feathers produce no sound on experiment. The rami are soft, like those of *G. gallinula*, and can easily be separated. The outer web is composed of rami provided, as in the case of *G. gallinula*, with rows of distal and proximal radii, of which many are well developed. In the inner web the distal row is one-third longer than the proximal, and is provided with 4 feeble hamuli. The rami are inserted into the shaft at an obtuse angle.

Its breeding-habits have been described by Prof. Collett, of Christiania, in Dresser's 'Birds of Europe,' vol. vii. p. 635:—"The Double Snipe is chiefly a nocturnal bird. Not only does it migrate at night, but it is in motion almost solely after twilight, when its peculiar 'spil' or drumming takes place; and it also searches after food chiefly during this time of the evening. . . . It has a so-called 'Leg' or 'Spil,' like some of the Grouse tribe, a sort of meeting-place, where they collect to 'drum' and often to engage in combat for the possession of the females. . . . It does not indulge in aerial evolutions, but remains on the ground. . . . The male bird utters a soft, almost warbling note, which is accompanied by a peculiar snapping sound caused by striking the mandibles together several times in quick succession. If a person approaches one of these drumming-places he can hear at some distance the low note: 'hip hip, bipbip, bipbiperere, bipere'; and when within 100 paces, if the night is still, he begins to hear other peculiar sounds. . . . Whilst producing these notes the bird is in ecstasy and raises and spreads its tail like a fan, the outer tail-feathers showing in the half-darkness like two white patches."

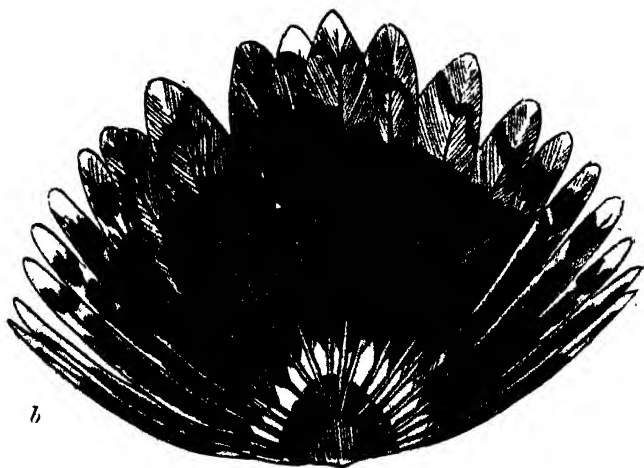
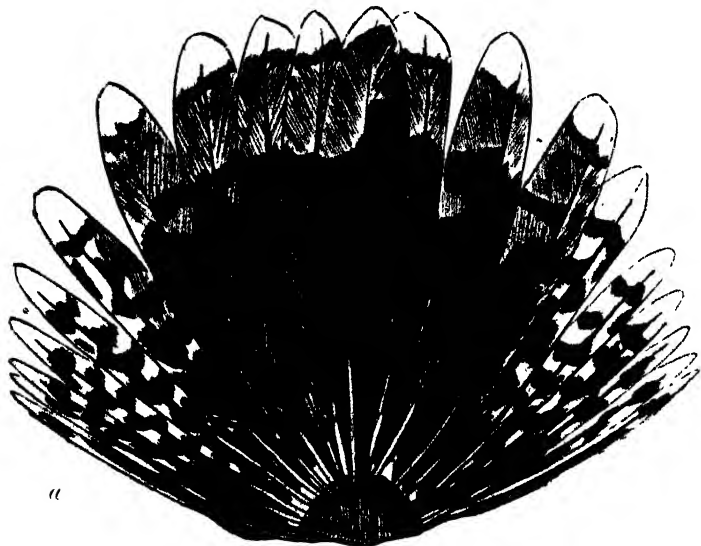
Here, again, having no experience of the aforementioned habits myself, I can only conjecture that the sound is vocal.

Now we come to a group of Asiatic species, which bear much resemblance to each other in the structure of their tail-feathers:—

*Gallinago solitaria* (text-fig. 9, a).—According to the formula for this species given in Seebohm's 'Geographical Distribution of

the Charadriidæ,' this species ought to have 18 tail-feathers; but a specimen sent me by Mr. Buturlin from the Western Tian Shan Mountains has 20 tail-feathers. The outer six are attenuated,

Text-fig. 9.

a. Tail of *Gallinago solitaria*.b. Tail of *G. megala*.

the first five markedly so. In this case both the outer and inner webs are very much narrower. Unlike any of the preceding species, the rami of the outer web are provided with fully developed

rows of distal and proximal radii, the former being provided with 4 hamuli in the same manner as the inner web. Herein this group differs notably from any of the preceding; the rami are short and stout, proximal and distal rows of radii the same size.

The bleat produced by these feathers is very loud, and consists of a number of notes of different pitch intermingled, caused apparently by the difference in breadth of the different musical feathers in the tail.

I venture to think that in this group the bleat is produced by the vibration of the feather as a whole, not by the inner web alone as in *G. celestis*.

An account of its breeding-habits is to be found in Hume and Marshall's 'Game Birds of India':— "They are to be heard and seen in the higher portion of the hills, soaring to a considerable height, repeatedly uttering a loud sharp, jerky call, and then descending rapidly with quivering wings and outspread tail, producing a hard buzzing sound, something like, but shriller and louder than, that produced by *G. celestis*, though they do not descend as rapidly as the latter."

*Gallinago megala*.—This species inhabits S.E. Siberia from Lake Baikal to the North Island of Japan. It possesses 20 tail-feathers, of which the outermost are  $\frac{1}{2}$  inch in diameter. The attenuated feathers are shorter than those from the middle of the tail (text-fig. 9, *b*). Microscopically they resemble those of *G. solitaria* in every way. The bleat they produce also resembles that of the foregoing species, but is far higher in tone. An account of its breeding-habits is to be found in Taczanowski's 'Fauna ornithologique de la Sibérie orientale,' p. 958, a reference kindly given me by Prof. Newton. I have translated the passage from the French: quoting from Prjevalski he says:— "That it retires to breed in the deepest marshes, covered with black scrub, and performs aerial evolutions as follows. The male sours up in the same way as our Snipe does, and after having described large circles in its flight above the place in which the female is nesting, it darts downwards in an oblique direction, making (probably with the rectrices, as does our Snipe) a loud sound, like the noise produced by a racquet when the handle has been broken. This noise gains more and more in intensity as it approaches the ground, and ceases about 100 paces from it, and then the bird continues its flight, repeating a note, which one can express by *tic-tic-tic*."

I have received a tail of this species from Central Siberia from Mr. Buturlin, who sends me this account from his first part of the 'Limnicolæ of Russia' (1902, pp. 77–78), an account contributed by the late M. Schwedow:—"After 6 o'clock P.M. (in May, near Irkutsk) one can see in the woods or on forest-swamps the 'forest Snipes' wheeling round and round in the air, and nearly always repeating in rapid succession notes like 'chwi, chwi, chwi,' or 'zswée, zswée, zswée.' From time to time one or other of the birds stops beating its wings, somewhat partially closes them, and swoops obliquely down, while vibrating notes are heard in the

air, somewhat like water pouring in the distance, gradually becoming higher and higher, and more sharply falling on the ear. The bird falls like an arrow, but when some fathoms from the tops of the trees it suddenly stops in the air and at the same moment uttering 'chic-ka-chee,' flies on again. After making some rounds in the air the bird silently or with the same sound 'zswi, zswi,' goes higher and higher in the air and recommences the same performance."

*Gallinago stenura* (text-fig. 8, C).—The Pin-tailed Snipe of India breeds in East Siberia, and possesses the greatest number of tail-feathers of the genus—26–28, of which the outer eight or nine are attenuated. The outer ones are so much attenuated that they actually do resemble pins. The outer feather measures  $\frac{1}{10}$  inch in diameter, the eighth  $\frac{1}{10}$  inch.

The outer web resembles that in *G. megala* in possessing fully developed radii; the number of the hamuli in the first pair is 5, in the eighth pair 4. The rami are short and thick. These feathers produce no sound on experiment. The passage from Swinhoe on Formosan Ornithology, 'Ibis,' 1863, p. 415, is the quotation from Taczanowski which I have just given and refers to the preceding species.

Mr. Buturlin writes of this species on the Kolyma:—"It was only one day, 25th June, 1905, that I could observe its breeding habits. . . . I watched it during two or three hours with strong binoculars at a distance sometimes of not more than 200 yards. . . . It flew about uttering a high, loud, somewhat harsh note, not clear enough to be styled a whistle, like 'psait, psait, psait,' and seemingly produced not by some *mechanical means*, but by its voice. From time to time (but not so often as our Common Snipe) the bird makes head foremost a dive in the air, just as our Common Snipe, but the descent is in time and distance quite twice as long as in the common species. When falling through the air the bird repeats its note more and more swiftly. . . . At the lowest point of its descent, the bird holds the wings high over its back, just like a swiftly descending pigeon or duck, and then ascends several feet without evident motion of its wings. I could not see any opening or spreading out of its tail, when swooping downwards."

John Hancock, writing in his 'Birds of Northumberland and Durham,' found great difficulty in accepting the tail theory, because of the diversity in structure of the tail-feathers to be met with in this genus, especially the feathers of *G. stenura*, which, he says, are considered to be musical instruments. Thus he raises a very reasonable objection, which I shall here quote:—"Other species have the same almost webless feathers at the sides of the tail, varying only in number. Here then we see a species in which the so-called sonorous or 'musical' feathers do not possess the structure, firmness of web, and length of rays, which appear to be mainly relied on as the sound-producers; though the rigidity and form of the shaft are in some way or other apparently

thought to have some influence in the production of the sound, independently of the rays or web. Were these feathers sonorous instruments, we should expect to find a greater uniformity in their structure. But, in fact, the tail-feathers of the true Snipes are remarkable for their diversity, so much so that the birds have been divided into four groups, and this mainly on account of a difference in the number and form of these feathers."

I have tried to show that the mechanism differs considerably in different species, just as the sound varies.

For reasons stated before, I believe that the bleat of *G. celestis* is produced by the vibration of the inner web as a whole; in the case of *G. frenata*, *nobilis*, and *australis* by vibrations of the individual rami; while *G. megala* and *solitaria* produce sounds of an entirely different character by vibration of the feather as a whole.

Finally, I will but briefly mention two species belonging to closely allied genera :—

*Scolopax rusticola*.—The Woodcock is known to perform certain evolutions during the breeding-season, producing at the same time a curious sound, which is acknowledged to be vocal. Certainly there is no evidence from examining the twelve feathers of the tail that any of them are specialised structures. The outer ones do not differ materially either in size or structure from any of the others. Microscopically the outer web is composed of plain rami provided with but rudimentary radii. The hamuli are four in number and their terminal portion is badly hooked.

*Philohela minor* (Gmel.).—The American Woodcock has 14 tail-feathers, of which the outer ones are decidedly shorter than the others; they produce no sound in experiment and are in macroscopical and microscopical structure similar to the last-named species. A good account of the habits of this bird in the breeding-season is to be found in Chapman's 'Birds of Eastern North America,' p. 153 :—"He begins on the ground with a formal, periodic, *peent peent*, an incongruous preparation for the wild rush that follows. It is repeated several times before he springs from the ground, and on whistling wings sweeps out the first loop of a spiral, which may take him 300 feet from the ground. Faster and faster he goes, louder and shriller sounds his wing song; then, after a moment's pause, with darting headlong flight, he pitches in zigzags to the earth, uttering as he falls a clear, twittering whistle. He generally returns to near the place from which he arose, and the *peent* is at once resumed as a preliminary to another round in the sky."

Certain of the primaries of the wing of this species are characteristically attenuated, for what purpose I am unable to discover, as they certainly do not produce any sound by any means I have employed.

I do trust that in the enquiries I have made I may be followed by

others. I cannot attempt to explain many of the facts I have set forth in this memoir; and yet an explanation ought to be forthcoming, and particularly in reference to the microscopical part of the subject on which I have mainly been able to dwell. The exact relations of the number and size of the barbules and hamuli to the sounds they produce is worth investigating, and still more is the cause of the breaks in the continuity of the sounds which you have heard—or, rather, not heard. This last would need the application of one who is intimately acquainted with the science of acoustics, which I make no pretence to be, and therefore I cannot offer any suggestion which will account for the non-continuity of the “bleating” or “humming”—its sudden stops and its sudden recurrence. There is much more to be learnt in this matter, and I would pray those who may be unconvinced by my experiments, at least to try to account for those marvellous sounds in some manner more satisfactory, and I assure them that there is no one who would be better pleased than myself to find that they can be so accounted for.

In conclusion, I should like to tender my sincere thanks to Prof. Newton, of Cambridge, without whose assistance the above facts would never have been recorded.

Since reading this paper I have received a skin of a female specimen of *G. aequatorialis*. The sound produced is disappointing in volume; in tone it bears a resemblance to that of the bleat of *G. celestis*.

### 3. Contributions to the Knowledge of the Systematic Arrangement and Anatomy of certain Genera and Species of Squamata. By FRANK E. BEDDARD, M.A., F.R.S., Prosector to the Society.

[Received December 7, 1906.]

(Text-figures 10–19.)

#### CONTENTS.

- (1) On some Specific Characters of Chamæleons shown in the Internal Organs, p. 35.
- (2) Some Notes upon *Chamæleolis*, p. 45.
- (3) The Position of the Umbilicus in certain Vipers, p. 50.
- (4) Some Notes upon the Anatomy of *Zonurus*, with Special Reference to the Hyoid, p. 52.
- (5) Some new Facts bearing upon the Affinities of *Gerrhonotus*, p. 56.
- (6) On a Point of Structural Resemblance between *Heloderma* and *Varanus*, and on some Specific Characters of *Varanus*, p. 59.

#### (1) *On some Specific Characters of Chamæleons shown in the Internal Organs.*

The external differences among Chamæleons are plainly set forth in vol. iii. of Boulenger's 'Catalogue of Lizards in the

British Museum.' The differences between the viscera of different species are by no means so well known. Indeed the only recent memoir known to me dealing with the visceral anatomy of Chamæleons, which also refers to specific differences within the genus, is that by Dr. Wiedersheim\*, chiefly dealing with the respiratory system in *Ch. vulgaris* and *Ch. monachus*. I have dissected, with reference to more than one point in the visceral anatomy, the following species, viz.: *Ch. vulgaris*, *Ch. calcarifer*, *Ch. dilepis*, *Ch. pumilus*, *Ch. parvilobus*, *Ch. taniobronchus*, *Ch. basiliscus*, and *Ch. verrucosus*. I am in consequence able to offer some additional anatomical facts concerning the genus, which are also of classificatory importance.

I may first of all call attention to an external character of the little-known *Chamæleon calcarifer*. One of the external characters which distinguishes *Ch. calcarifer* from *Ch. vulgaris* is the presence in the former of a more distinct ventral crest composed of a line of conical and, at times, overlapping "enlarged granules." This line is traceable, but is by no means so well marked, in *Ch. vulgaris*. The division of these ventral scutes which marks the position of the umbilicus in the fœtus is therefore exceedingly obvious in *Ch. calcarifer* and less easily to be mapped out in *Ch. vulgaris*. It lies behind the middle line of the body. It is represented by a long space contained in the middle of the ventral crest, which bifurcates to embrace it, and in this region therefore is double. The number of scales on the two sides is uneven; I counted 13 on the left and 11 on the right side. The size of the region of the integument which appears to mark the umbilicus was rather greater in *Ch. vulgaris*, but, as already said, the indistinctness of the ventral crest renders it difficult to be accurate. In *Ch. dilepis* this area was quite as distinct as in *Ch. calcarifer* and occupied the same position; there were, however, only 10 pairs of scales, closely apposed.

The lungs show some variation in structure from species to species. That there is some variation in these organs has already been pointed out by Wiedersheim, who figures those of *Ch. vulgaris* and of *Ch. monachus*. The differences seem mainly to affect the number and form of the tags which are appended to the lungs, those very characteristic anangious outgrowths of the lung. Wiedersheim distinguishes between the more or less cylindrical outgrowths and the branches of the lung itself which bear them. The outgrowths, which exist more anteriorly and always on the ventral side of the lung, are simply the tubular cæca. Towards the end of the lung the lung itself is divided into several processes. In a young example the author quoted found that the cæca were solid. There is therefore reason for distinguishing the pulmonary cæca from the lungs, and a careful examination of both shows a ceasing of the reticular bands which cover even the anangious part of the lungs. As the number of outgrowths not

\* Ber. naturf. Ges. Freiburg-i.-Br., Bd. i. 1880, Heft 3.

only varies in individuals, but also on the two sides of the body of the same specimen, their mere number and arrangement can hardly be utilised as distinctive of species without examining a large series. Yet I am disposed to think, for reasons that will be discussed later, that *Ch. monachus* does differ from *Ch. vulgaris*.

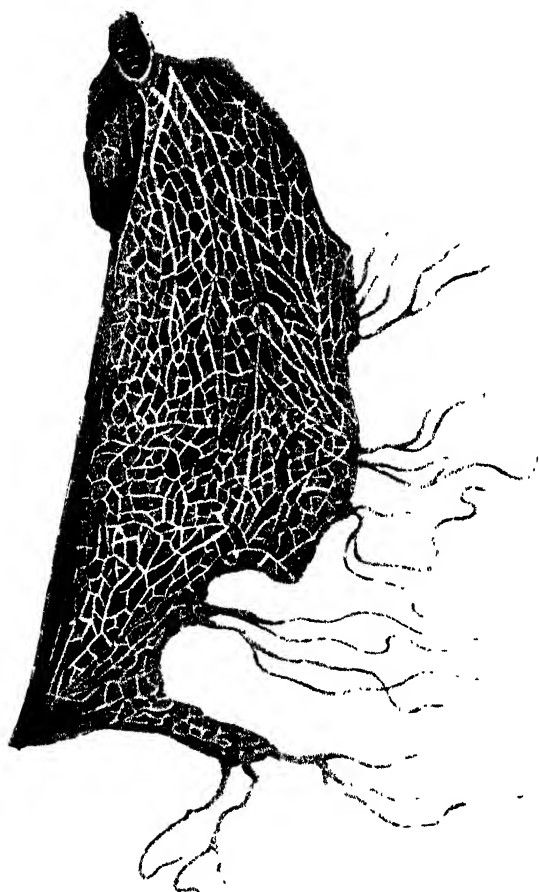
In *Chamæleon calcarifer* the lungs show the same general structure as do those of *Ch. vulgaris*. That is to say, the lung itself is frayed out into processes posteriorly. These again may or may not give rise to the tubular cæcal outgrowths. The latter show no network upon their surface, but the direction of the fibres of which they are partly composed is rather circular. On the ventral side also, some way in front of the end of the lung, the lung itself is prolonged into processes. I counted altogether in one lung examined fifteen tubular cæcal outgrowths. But as the numbers have been stated by Wiedersheim to vary in *Ch. vulgaris*, the exact number is probably not a matter of importance. They were, however, certainly more numerous than in an example of *Ch. vulgaris* which I have myself studied. What appears to be of importance is to note that the lung itself is divided and that the tubular outgrowths do not arise from a lung with an entire margin. The subdivisions of the cavity of the lung seem to be exactly as Wiedersheim has described for *Ch. vulgaris*. In *Ch. verrucosus* the tubular cæcal outgrowths are very numerous. I counted twenty-five or more of them. All the cæcal outgrowths were borne in four tufts, of which that furthest from the bronchus was the largest, and consisted also of an outgrowth of the lung itself. The individual tubular cæca were frequently to be seen arising by the division of a common stem (text-fig. 10, p. 38). The disposition of the cæca in this species is very different from that which I have observed in others.

The lungs of *Chamæleon dilepis* appear to differ in certain respects from those of the species that have been hitherto described. The obvious difference is the tubular character of the cæcal outgrowths, which have hardly any dilated termination, shown so plainly in *Ch. parvilobus*, for example (text-fig. 12, p. 39). In the second place, the tubular cæca are thick-walled and not at all transparent except in parts, and then not so transparent as in other species. Furthermore, these processes are distinctly shorter in *Ch. dilepis* than they are in *Ch. parvilobus*, as is indicated in the annexed figure (text-fig. 11, p. 39). The differences above set forth can hardly be due merely to a different state of contraction, since both specimens came out of the same bottle of alcohol in which they had been preserved some time since; and very well preserved, for there was no trace of softening or disintegration of the viscera. The cæca of *Ch. dilepis* are certainly to some extent contracted, as they can be pulled out without using undue force. There remains, however, a condition which differs from the attenuated and thin cæca of *Ch. parvilobus* and *Ch. verrucosus* on the one hand, and from the prolongation of lung-substance with shorter cæca in *Ch. calcarifer*, on the other. The marked distinctness of the cæca from the lung



is, in fact, a feature of this species as contrasted with those that have been mentioned. It will be observed in the figure (text-fig. 11) that the lung terminates in a cæcum which continues in the same straight line. This seems to be the case also with other species. It suggests, of course, the distal terminal air-sac (abdominal air-sac)

Text-fig. 10.



Lung of *Chamæleon verrucosus*, entire.

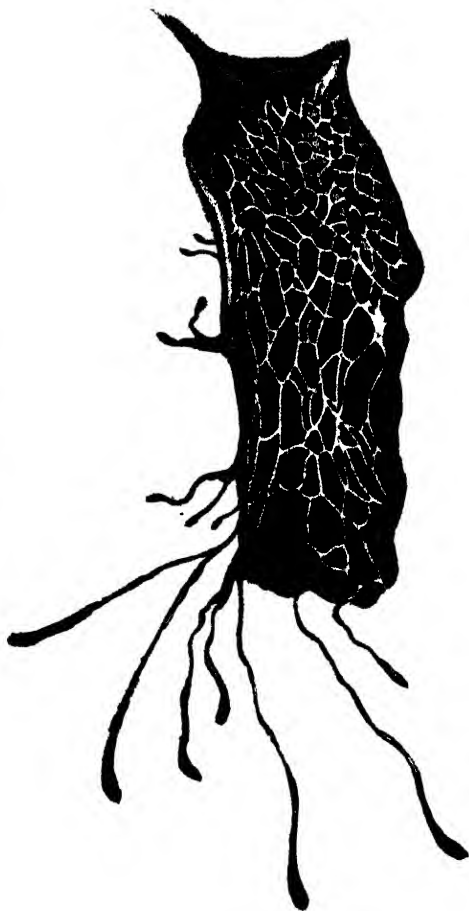
of the bird's lung. The arrangement of the other cæca is shown in the figure referred to. They are developed along a considerable region of the ventral margin of the lung. The larger number of the cæca are, however, massed at one spot, which is not at the end of the lung as in *Ch. parvilobus*, but at about its middle. Another

noteworthy difference about these cæca as compared with those of other species which I have examined, is that there is an anastomosis between the roots emerging separately from the lung. Finally, the small number of cæca as compared, for example, with *Ch. calcarifer* is a fact worthy of attention, since it is the beginning of the immense reduction seen in *Ch. basiliscus*, which culminates in the total absence of these cæca in *Ch. pumilus*.

Text-fig. 11.



Text-fig. 12.

Text-fig. 11.—Lung of *Chamæleon dilepis*, entire.Text-fig. 12.—Lung of *Chamæleon parvilobus*, opened longitudinally.

The above description also applies in generalities to the right lung of the same individual. That is to say, with regard to the shortness, tubular character, and fewness of the cæcal outgrowths.

A specimen which I had the opportunity of examining fresh showed how the lungs may vary in individuals, as was pointed out by Wiedersheim. This variation consists principally in the larger number of cæca. I should mention, however, first of all that there is just a shadow of a doubt as to the identity of the species. In the second smaller specimen the occipital lobes characteristic of the species were disproportionately smaller than in the larger individual, whose lungs I have already described. In the second place, the larger individual had no trace whatever of the "Hohlenvenenfortsatz" of the right lobe of the liver accompanying the postcaval vein. In the smaller individual there was a considerable process of hepatic tissue accompanying the postcaval vein for some distance.

In the case of both right and left lung, the lung ended, in the same way as in the example already described, in one bifid cæcum, bifid from the very first. In one lung I counted 14 other cæcal outgrowths, of which five were particularly short. In the other lung I found as many as 16 outgrowths, of which only three or four were short. Two, or even three, sometimes borne upon the same stem. The cæca are of considerable diameter and clubbed in form; they contrast markedly with those of *Ch. verrucosus*.

I have also selected for figuring the lung of *Ch. parvicolus* (text-fig. 12), which is at the very opposite extremity from the other species figured in the present communication, viz. *Ch. dilepis*. The cæca are numerous and extremely slender and in some cases of great length. Thus the longest measures 33 mm. as against 32 mm. of the length of the lung itself, and there are several other cæca nearly or quite as long. The longest of the diverticula are at the posterior end of the lung. The whole ventral border is also beset with diverticula, but these are invariably short; all show a marked dilatation at the free extremity. In contrasting these slender extended diverticula with the short thick diverticula of the two species *Ch. dilepis* and *Ch. basiliscus*, to be described immediately, one is disposed to believe that greater contractility in the case of the two latter may account for the great difference which they show from the species here under consideration; especially since Milani's figure\* of the lung of *Ch. basiliscus* indicates long slender diverticula with slightly pronounced dilatations at their extremities.

*Chamaeleon basiliscus* has lungs which have been described by Milani† and which agree most nearly perhaps with those of *Ch. dilepis*. The lung itself is extensive and reaches back nearly to the kidney. The specimen which I had the opportunity of examining had been preserved for some time in alcohol. In neither lung could I find any cæca depending from the ventral margin of the organ, and in the left lung I did not find more than a single cæcum at the posterior end of the lung, but conspicuous enough when detected by its yellow colour as contrasted with the colourless and transparent wall of the lung itself. In the

\* Zool. Jahrb. (Abth. f. Anat.) vii. p. 577.

† Loc. cit. p. 676.

right lung, however, though there was a perfect agreement with the left lung in the absence of any ventral caecal outgrowths, such as occur in other Chamæleons, there were three obvious cæca at posterior end. Milani figures five cæca. These were quite tubular and not swollen at the free extremity, as, for instance, in *Ch. parvilobus*. The walls are thick and they arise from a thick-walled portion of the lung. These cæca are, in fact, exactly like those of *Ch. dilepis*, from which the present species mainly differs in the extreme fewness of the cæca, as is apparent from Milani's figure.

*Chamaeleon pumilus* has lungs which differ in several important points from those of the species that have been hitherto considered. In the first place, there are no signs whatever of any bronchi in the lungs. When the left lung is opened and the appearances presented compared with those to be seen in *Ch. vulgaris*, the following differences are recognisable. In both the aperture of communication between the two lungs, which represents, of course, the distal extremity of the bronchus, permits the interior of the right lung to be to some extent viewed. In the case of *Ch. vulgaris* the cartilaginous rings of the bronchus have to be cut up in order to display fully the aperture into the right lung through which are seen the cartilaginous rings of the bronchus of the right lung. In *Ch. pumilus*, when the lateral wall of the left lung is removed no trace whatever of any bronchus is seen; there is simply a large circular orifice putting the two lungs into communication, which shows no traces of any bronchial cartilages that can be detected by the unaided eye. It is not plain whether this condition is to be regarded as primitive or as evidence of degeneration. The lung itself is considerably shorter, relatively as well as actually, than in the species which has been dealt with in the preceding lines. It is, furthermore, different from the lungs of these other species in that the typical lung-structure persists throughout the whole sac. The alveoli in the lungs of Chamæleons generally are smaller and deeper proximally and get larger and shallower posteriorly, ultimately becoming practically invisible. The hinder region of the lung is anangious. In *Chamaeleon pumilus* the alveoli become rather less marked posteriorly, but they are much more conspicuously circumscribed up to the very end of the lung than is the case with any of the larger species which I have had the opportunity of examining. The lung, in fact, is less metamorphosed into a mere air-sac in the present species than in any other which I have examined, excepting only *Ch. temnobronchus*, to which species I shall have to refer again immediately. In this particular it is plain that the lung of *Ch. pumilus* is more typically Lacertilian than that of such a species as *Ch. vulgaris* or *Ch. calcarifer*.

A final peculiarity shown by the lung of this species is very remarkable. It has been stated in many general works that the Chamæleons as a family are to be characterised by the caecal outgrowths of the lungs, which have been considered in several

species in the foregoing pages, and that is certainly the general impression among zoologists and anatomists. I was greatly surprised therefore to find that the lungs of *Ch. pumilus* are quite unprovided with these otherwise characteristic outgrowths. The margin of the lungs is entire and slightly sinuous, the convexities occurring in the sinuous line being perhaps to be looked upon as rudiments or incipia of the cæcal appendages. It will be observed that the absence of these cæca is associated with a more complete retention of the typical pulmonary structure of the lung, and therefore its greater efficiency as a breathing-organ. On the other hand, it is to be noted that where the cæcal tubes exist the lung itself has lost considerably the alveolate structure and thus presumably some of its efficiency as a breathing-organ. The Ophidia particularly show that the lung may be too large for its office as a respiratory organ, and they, like the Chamæleons, are often lethargic in habit.

The above account of the lungs of *Chamæleon pumilus* is, in so far as the absence of tags is concerned, in harmony with the description of both Meckel\* and Cuvier†. The latter observes: "*Le Caméléon nain n'a rien de pareil; ses poulmons sont deux petits sacs simples, ovales, de grandeur égale, comme ceux de la plupart des Sauriens*"; and on another page: "*Ils manquent d'appendices*." Milani, however, obviously doubts these statements in writing‡ as he does: "*Ob bei Chamæleon pumilus die Zipfel wirklich fehlen, oder ob diese Behauptung nicht vielleicht auf ein mangelhaftes Präparat zurückzuführen ist, wage ich hier nicht zu entscheiden*." It is because of the latter doubt cast upon the facts that I have entered into the matter at some length, and, as I hope, settled it.

I have finally to add to the description of the lungs in various Chamæleons that *Ch. tenuibronchus* agrees entirely with *Ch. pumilus* in the total absence of diverticula, an agreement which is very significant in view of other facts.

The *pigmentation of the interior of the body* varies among the species of this genus. In all that I have examined the intestinal tract is a deep black, and there are generally (but not in *Ch. verrucosus*) patches of pigment upon the stomach not distributed so universally. The mesenteron is largely pigmented anteriorly in *Ch. verrucosus*. There is no variation, however, in the pigmentation of the gut. The parietal walls are not so generally pigmented. It is, indeed, only in *Ch. pumilus* and in *Ch. tenuibronchus*, among the species which I have examined, that the whole of the lining peritoneum of the body is of a deep black, quite as deep as is the gut. This pigmentation also extends to the mesenteries. In all of the remaining species the pigmentation of the general body-cavity and the mesenteries is hardly to be seen and only exists in very slight degree, so as not to affect the

\* "Respirationsystem der Reptilien," Deutsch. Arch. f. d. Phys., 1818.

† Leçons d'Anat. Comp. 2me éd. par Duvernoy, t. vii. (Paris, 1840).

‡ Zool. Jahrb. (Abth. f. Anat.) vii. p. 573, footnote.

general appearance. This peculiarity at once divides the two species mentioned from the rest, and other anatomical peculiarities described in the present communication tend to show the separateness of these two *Chamæleons* from others.

It may be remarked that the table of external characters used by Boulenger in the discrimination of the species of the genus brings together *Ch. pumilus* and *Ch. tæniobronchus* \*.

*Pancreas*.—The shape of this organ shows differences in the species of *Chamæleon* which I have examined. In all it lies partly between the stomach and the recurrent loop of the duodenum, and partly dorsal of the stomach and to the posterior side of that organ. That is to say, when the reptile is dissected and viewed in the ordinary position lying on the right side part of the pancreas, that lying between the stomach and the duodenum is visible and the rest is seen when the stomach is raised. The main differences in form are the relative thickness of the gland and the relations of the splenic lobe, which here, as in other Lizards, is to be distinguished at least to some extent from the rest of the gland. The distinction between the two lobes of the pancreas is most plainly to be observed in *Ch. dilepis*, where the splenic lobe is quite at right angles with the rest of the gland, and the duodenal part is continued on for a very short distance before it gives off the splenic lobe. In all the remaining species there is no such marked distinction, the two lobes forming one curved elongated mass. This is particularly plain in *Ch. tæniobronchus*, where the coils of the intestine lie entirely behind the pylorus, and the pancreas is therefore exposed for its whole length and not partially hidden by the stomach. I shall recur later to the coiling of the intestine in this and other species of *Chamæleon*.

The bulk of the gland differs greatly in the several species. In some it is much thinner than in others, and therefore, as the length is not far from being the same, relatively as to the size of the species the actual bulk fluctuates. Two extremes are well seen in the two species *Ch. dilepis* and *Ch. calcarifer*, which, on account of their practically identical size, show the facts very plainly. In *Ch. dilepis* the gland is very thick, quite as thick as the diameter of the adjacent pyloric region of the stomach; its greatest diameter is about 6 mm. On the other hand, in *Ch. calcarifer* the pancreas is comparatively quite excessively slender, and only measures 3 mm. or so in transverse diameter in the region which lies ventrally and in front of the stomach. There are similar differences between other species; but I do not give details, as the individual species vary so much in size that a comparison of the glands would involve rather complex measurements; these would be of more value if the number of individuals examined were large. The prominent and easily recognisable differences between the two species selected will serve as an example of what also occurs elsewhere in the genus. There are, however, too great a series of

\* Cat. Lizards Brit. Mus. vol. iii. 1887, p. 440.

gradations between the extremes to permit of the use in classification of the dimensions of this gland.

*Liver-lobes.*—The proportions of the two lobes of the liver\* differ markedly in several species of the Chamæleons reported upon in the present communication. Thus in *Ch. pumilus* the right and left lobes are so nearly equal that only one can be seen with just traces of the other when the viscera are viewed from the left side. The gall-bladder is partly covered by the extensive left lobe, which, moreover, comes into contact with the stomach.

The most extremely opposite conditions to these are shown (so far as the material in my hands enables me to say) in *Ch. calcarifer*. In that Chamæleon the left liver-lobe is very much shorter than the right. When the animal is viewed in the same posture as the last, the left lobe leaves exposed a section of the right lobe as long as itself, and does not even reach the gall-bladder, which lies on the right lobe not very far from its tip. There is, of course, no contact between the left lobe of the liver and the stomach, the ventrally flexed region of which lies considerably behind the end of even the right liver-lobe.

In *Ch. basiliscus* the viscera in question are arranged and have very much the same proportions as in *Ch. calcarifer*. The same may also be said of the Common Chamæleon (*Ch. vulgaris*) and of *Ch. verrucosus*†. In *Ch. parvilobus* the two lobes of the liver are approximately equal, and the left lobe completely conceals the gall-bladder when that viscus is viewed from the left side. On the other hand, it, the left lobe, does not come so near to the stomach as in *Ch. pumilus*. Very much the same description will serve for *Ch. dilepis*, save for the fact that in this Chamæleon the gall-bladder is not so completely hidden by the left lobe as in *Ch. parvilobus* and *Ch. pumilus*. The characters of the liver, therefore, hardly allow of any grouping of the species; for there are gradations. The *alimentary canal* does, however, show certain differences which permit of a grouping such as has been already suggested.

In *Ch. calcarifer* and the other larger species the intestine is as well coiled as in other Lacertilia, and when the animal is opened from the side a good deal of the small intestine is seen to lie in a coil with secondary convolutions in front of, *i. e.* headward of, the pyloric end of the stomach. The stomach, in fact, partly covers a section of the small intestine when the viscera are viewed from the left side. In *Ch. pumilus* there is only one short bend of duodenum, which lies in front of the stomach. But the opposite extreme to *Ch. calcarifer* is to be seen in *Ch. tenebrosus*. In this small Chamæleon the end of the stomach is not bent upon itself at all, but is continued back in a straight line to join the intestine, which is but little coiled upon itself. Moreover, the whole length of the intestine lies completely behind the stomach.

\* The liver itself is very compact in these reptiles, unlobulated, and with very firm outlines.

† I could see no gall-bladder in this species.

There is thus a simplification in the coiling of the gut in this very small species which is not so strongly marked in the rather larger but still small *Ch. pumilus*. It is not without interest to note this apparent relation between smallness of size and simplification of structure shown also in the lungs of these species, as has been already commented upon\*.

(2) *Some Notes upon Chamæleolis.*

This Lizard is placed among the Iguanidæ in spite of its superficial likeness to a Chamæleon. Indeed this superficial likeness is not after all very striking, and depends mainly upon the fact that the head is prolonged behind and above into a parietal crest. Nevertheless it is of advantage to be able to record a few facts in the visceral anatomy which distinctly confirm the placing of this genus in the immediate neighbourhood of *Iguana*. It has, moreover, its own peculiarities as compared with that genus; and therefore as a contribution to the visceral anatomy of the Lacertilia I am laying before the Society such facts as I have gathered from a dissection of a female individual. The existing knowledge of the anatomy of the Lacertilia shows that there are four marked structural features in which all the Iguanidæ that have been examined agree with each other, and the combination of which allows them to be defined. I shall, therefore, first of all deal with these four points, which together prove that *Chamæleolis* has been rightly placed among those Lizards.

In the first place, the umbilical ligament which divides the two liver-lobes and is attached to the ventral median line of the body is a single ligament which runs continuously from end to end of the liver, without any trace of a posterior division upon the liver, as I have lately figured in *Iguana*†. The gall-bladder is left to the right of this ligament. In these particulars the umbilical ligament of *Chamæleolis* is precisely like that of *Iguana*, and there is no need to illustrate the relations of the ligament by a figure. I may mention that it is deeply pigmented.

A second feature, which, though a small character, appears to be a constant one, is the position of the intercostal arteries in relation to the vertebræ. In *Chamæleolis*, as in some other Iguanoids, these arteries plunge into the thickness of the dorsal parietes towards the posterior end of each vertebra; in some other Lizards they disappear from view at about the middle of each vertebra. Of course, *Chamæleolis* has the same regular arrangement of pairs of these arteries as in other Lizards, a feature, indeed, which seems to differentiate the Lacertilia from the Snakes, at least broadly considered.

Thirdly, Milani‡, whose account of the Lacertilian lungs is the most recent and comprehensive known to me, has found that in the Iguanidæ the lung is totally divided into two chambers, of

\* *Supra*, pp. 39 & 41.

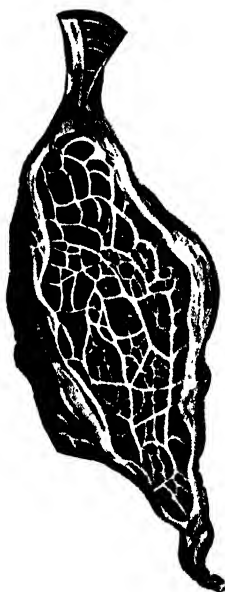
† P. Z. S. 1905, vol. i. p. 12, fig. 7.

‡ Zool. Jahrb. (Abth. f. Anat.) vii. p. 545.



which the more dorsal extends headwards of the orifice of the bronchus. This statement at any rate holds good for the majority of the Iguanidæ that have been examined. *Chamaeleolis* does not agree with these types, for the lung is not divided by an obliquely placed septum into two approximately parallel chambers. It is, nevertheless, not to be removed from the Iguanidæ on this account, since it appears to present points of likeness to the undoubtedly Squamoid *Phrynosoma*, and one point at least of resemblance to the Iguanoid genus *Polychrus*.

Text-fig. 13.



Lung of *Chamaeleolis*, opened longitudinally.

The bronchus enters for a short distance into the lung as a completely circular tube; there is no snake-like series of flattened semirings such as is to be found in *Iguana*\*. The projecting bronchus is, as in *Phrynosoma*, moored to the walls of the lung by septa. The cavity of the lung, therefore, extends headwards of the opening of the bronchus and all round it. There is no septum in either lung which separates off the dorsally placed cæcum of the lung as a distinct cavity from the rest of the cavity of the organ. In the left lung the structure happened to be more favourable for observation than the right lung, and I have accordingly had a drawing prepared (text-fig. 13) of the interior of this lung. It

\* Milani, *loc. cit.* pl. xxxi. fig. 13.

will be there seen that the strong septa which produce a pouching of the dorsal region of the lung in other Iguanids and Agamids are also to be seen in *Chamaleolis*. I observed six of the chambers altogether, of which three would appear to belong to the anterior part of the lung, *i. e.*, that region which is in other Iguanids divided off by a septum from the posterior region, and three larger pouches belonging to the posterior region of the lung. Finally, the end of the lung abruptly narrows and forms a finger-shaped region with a but slightly marked network. It seems to me to be possible to compare this with the *Chamæleon*-like outgrowths of the lung in *Polychrus marmoratus* \*.

In the fourth place, the right extremity of the liver is attached by a fold of membrane which separates the lung from the post-hepatic region of the body-cavity and is continuous with the oviducal membrane.

Besides these points, which, together with various external and osteological characters used by others, fix the systematic position of *Chamaleolis*, there are other features in its anatomy which I have ascertained and which are worth noting as a contribution to Lacertilian structure.

The pigmentation of the body-cavity is in some ways remarkable. The umbilical ligament, not only the region which is attached to the liver, but that which is attached to the stomach, is deep black, and in the latter region contrasts with the yellowish gut. The gut itself is, however, pigmented in the case of the large intestine. This pigmentation is limited to the dorsal side of the gut and involves the whole of the cæcum. The appearance presented is, indeed, of two tubes closely applied, of which one is the small intestine and the other ends at the blind extremity of the cæcum.

As in many Lacertilia, the peritoneum generally is deeply pigmented, and a distinction is to be drawn between the posterior pigmented region and the anterior region of the body-cavity, where its walls are not pigmented at all, so far as naked-eye appearances go.

While, however, in most Lacertilia this line of demarcation is quite oblique, bending ventrally in a continuous curve, it is in *Chamaleolis* quite transverse (to the longitudinal axis of the body) in direction, but with a curved outline, now convex, now concave.

The existence of bundles of plain muscular fibres in the mesenteries reaches a very great degree of development in many Lacertilia. In the Lizard which forms the subject of the present communication there was no development of such fibres that could be seen with the unaided eye. The ovaries contained no mature ova. There was a fully formed egg in each oviduct, with a dirty white shell of leathery consistency. There was no trace of an embryo in the egg.

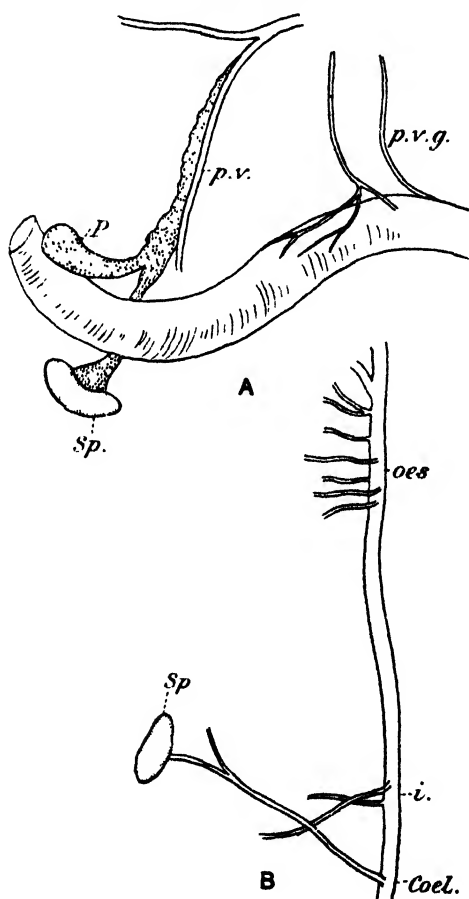
The apex of the heart is fixed to the pericardium by a very

\* Milani, *loc. cit.* pl. xxxi. fig. 15.

slender gubernaculum cordis, a structure which is rarely absent from the heart of the Lacertilia\*.

The arterial system presents certain peculiarities as compared with that of other Lacertilia. The disposition of the intercostal

Text-fig. 14.



A. Stomach and pancreas of *Chamaeleolis*.

P. Pancreas; p.v. Portal vein; p.v.g. Gastric portal; Sp. Spleen.

B. Dorsal aorta and branches of the same.

Coel. Coeliac artery; i. Intestinal arteries; oes. Oesophageal arteries; Sp. Spleen.

arteries has already been mentioned as a point of affinity with the Iguanidæ. The visceral arteries (text-fig. 14) which supply the

\* But is absent in *Varanus* occasionally (see Beddard, P. Z. S. 1906, vol. ii. p. 617 footnote) and *Zonurus giganteus* (*infra*, p. 55).

alimentary canal are collected into two groups, leaving a tract of considerable length from which no arteries to the gut arise. The anterior group is situated just behind the union of the two aortic arches, and consists of no less than seven small arteries supplying the œsophagus and stomach. These arise from both sides of the aorta and are partly arranged in pairs; they run to both sides of the stomach. There is then a long gap until the origin of the intestinal arteries. The general plan of these is like that in most Lacertilia; but there are differences in detail from those of many genera. When the mesentery is turned over to the right the cæcal artery which arises most anteriorly is seen to run over the following duodenal artery, but under the third artery, that which supplies the spleen, &c.

With regard to the venous system, the only notes that I have made refer to the hepatic portal system. The junction of the anterior abdominal and the main portal trunk is very near to the conjoint entrance of both into the liver—much nearer than is the case with many Lizards. In addition to this, the chief portal trunk, there are two vessels which pour blood direct from the stomach into the liver (text-fig. 14): one of these, the more posterior in position and the larger, is associated with the left lobe; the other, a slender twig, enters the liver to the right of the last described. The ventral parietal hepatics are also two, of which one is a little to the right of the other in its point of entrance to the liver. Both are rather far forward on the liver. There is but one dorsal parieto-hepatic. This, as is the case with other Lizards\*, is associated with the "Hohlvenenfortsatz" of the liver, and runs in the mesentery, binding that lobe of the liver to the right parietes. It runs a considerable way forwards along the vertebral column before becoming lost in the thickness of the parietes.

The *pancreas* of *Chamaeleolis* (text-fig. 14) is constructed upon the usual Lacertilian plan, but differs in various details from that of other Lizards. It is a Y-shaped gland and completely solid throughout. There are no thin diffuse branches spread through the mesentery such as are to be found in the case of the pancreas of *Zonurus giganteus*†. One arm of the Y ends, after dilating slightly, in the concavity of the somewhat bean-shaped spleen; the other forms a thick mass in contact with the commencement of the duodenum. The stem of the Y forms a thin rod of pancreatic tissue, which closely accompanies the portal vein and very nearly touches the liver. This region of the pancreas seems to me to be longer than in some other Lacertilia, though in most there is a process of the pancreas running in the same direction. The splenic lobe of the pancreas is not extraordinarily thin, as it is in *Tiliqua scincoides*‡, but of fairly robust diameter.

\* The absence of this vessel is rare, but Hochstetter, whom I have been able to confirm, has asserted its absence in *Chamaeleon vulgaris*. I take this opportunity of stating that this vein is also absent in *Chamaeleon verrucosus*.

† *Vide infra*, p. 55.

‡ See Beddard, P. Z. S. 1905, vol. ii. p. 262.

(3) *The Position of the Umbilicus in certain Vipers.*

I am not aware that the point of entrance of the umbilical sac into the body in Snakes has ever been made use of as a systematic character. I find, however, from a few observations that I have been able to make recently, that this anatomical relationship is apparently of systematic value. Since of one species, viz. *Lachesis lanceolatus*, selected for these observations, I have been able to examine a considerable number of individuals, the variation of the character from one individual to another became a matter of additional interest, especially in view of the fact that all the individuals were of one brood. It appears that in Vipers, as compared at any rate with the Anaconda\*, the umbilicus is much nearer to the cloacal aperture. I have examined fourteen individuals of *Lachesis lanceolatus* of the same brood and of approximately the same size, though they died on different dates, from March the 9th to May. The length varied from  $11\frac{1}{2}$  to 12 inches exclusive of the short tail. I do not give measurements in millimetres, since to use such gives an appearance of rigid accuracy not attainable in a dead snake capable of artificial extension and shortening. In nearly all of these fourteen individuals four scales occupied the umbilical region, each of them being bisected by a groove running longitudinally to the axis of the body. I found, in fact, that there were four scales thus modified in eleven individuals. In two of the remaining snakes there were five of these scales in which the two sides had not joined across the middle ventral line, and in the fourteenth individual only three scales and a portion of the fourth; the number of scales intervening between the last of the "umbilical" scales and the anal scale varied a good deal but within very narrow limits. The actual facts are these: in three specimens 17 scales intervened between the points mentioned; in one specimen 18 scales; in five others 19 scales; in three 20 scales; in one 21 scales; and, finally, in one 22 scales. The average is thus arithmetically 19, and actually there were more specimens exhibiting the average than any other number. Having due regard to the narrow range of the variation, it seems likely that the position of the umbilicus in this species of Viper can be regarded with safety as lying 19 scales in front of the anal scale. It is important to notice the length of time during which this foetal character is retained. The last specimens examined by myself died on May 15th of last year. These and the other individuals were acquired by the Society on Dec. 12th, 1905. The last specimens examined by me were therefore more than six months old. I have some confidence, therefore, in comparing *Lachesis lanceolatus* in respect of these characters with other Vipers of an obviously greater age. I may first of all, however, refer to newly-born Vipers which I have recently dealt with† in

\* See Beddard, P. Z. S. 1906, vol. i. p. 13.

† P. Z. S. 1906, vol. i. p. 34.

a paper communicated to this Society. It is impossible to be certain of the exact position of the actual umbilicus in *Lachesis lanceolatus* for the purposes of comparison between these two types, *i. e.*, which of the four or five broken scales correspond to the two scales in *Bitis nasicornis* which are actually divided by the fetal blood-vessels. Assuming, however, that they are even the last two, there still remains a substantial difference in position between the umbilicus of the two species. For in *Bitis nasicornis* the actual numbers of scales intervening between the umbilicus and the anal scale are respectively in the five examples studied 9, 11, 11, 12, 14. There is thus exactly the same amount of variation as in *Lachesis lanceolatus*, but round a different mean.

The position of the umbilicus in Russell's Viper (*Vipera russellii*) is again different and relatively more fixed than in either of the species hitherto considered. As in *Bitis nasicornis*, the actual umbilicus consists of two scales only, which do not meet ventrally, and between which the plug of tissue bearing the umbilical vein &c. passes into the interior of the body. The young Vipers in question were a very few days old, but all external traces of the yolk-sac had disappeared. In front of these two scales either two or three scales were divided by a suture in the middle ventral line, and posteriorly to the two "umbilical scales" either one or two scales were similarly split by a ventral suture. Between the last of the two completely divided scales and the anal scale there intervene in the five examples examined respectively 16, 16, 16, 17, 17 scales. The position of the umbilicus is therefore different in this Viper, and its fluctuations of position are less than in the two species to which I have already called attention. It is perhaps permissible to call attention to the fact that *Vipera* and *Lachesis* agree with one another more nearly than either does with *Bitis*. This is, of course, not in accord with generally received views upon the classification of Vipers.

I have examined several Vipers of more mature age, and in two specimens, at any rate, I find what appear to be obvious traces of the umbilicus. In a not fully-grown example of *Bitis arietans* measuring 30 inches from the snout to the cloaca, four scales showed a line of division in the ventral median line. The second of these had the most strongly marked groove, and possibly therefore represents one of the two scales already described in the young as immediately surrounding the stalk of the yolk-sac. Between the last of the grooved scales and the anal scale 9 scales intervened. The species evidently therefore comes nearest to the other species of *Bitis* which has been described above. In a second specimen measuring 32 inches there were 12 scales between the last of four grooved scales and the anal scale. I have also seen similar traces in a large adult example of *Bitis gabonica*. Here there were also four scales showing traces of the umbilicus; but instead of being grooved they were merely nicked posteriorly. Between the last of them and the anal scale 8 scales intervened

It is not safe upon these two last-mentioned examples to attempt to draw any distinctions between the different species of *Bitis*. It seems, however, to be most probable that they do not differ widely from each other as regards the points under discussion, whether they will ultimately be found to differ specifically or not. It is, however, quite plain, in reviewing all the facts brought forward in the present communication, that the position of the umbilicus among Vipers is one that does at least characterise some forms which happen in the instances studied to be generically separated.

(4) *Some Notes upon the Anatomy of Zonurus, with Special Reference to the Hyoid.*

The following notes refer to three specimens of *Zonurus giganteus* which I have had the opportunity of dissecting during the last year or two. The anatomy of this Lizard is already to some extent known through the work of previous observers. The lungs have been dealt with by Milani\* in his general account of these organs among the Lacertilia, and the arteries of the gastric and intestinal regions are described and figured by Hochstetter†. There remain, however, a few points to which it is worth while calling attention as a further contribution to the natural history of this Lacertilian.

Of special importance—rather, however, from a general point of view than as a particular contribution to our knowledge of this Lizard—is the condition of the elements which together make up the hyoid complex of bones and cartilages in this Lacertilian. I am able to add to what I have to say concerning *Zonurus* a few notes upon other genera of Lacertilia which I have dissected for purposes of comparison. I commence with a brief *résumé* of some of the facts already known of this part of the skeleton.

The hyoid and branchial arches of Lacertilia have not, as it appears, been investigated in a very large number of genera. Several are figured in the volume‡ of Bronn's 'Thierreich' dealing with the Lacertilia, while other genera have been illustrated by subsequent writers§. Apart from differences in the form of the individual elements of the hyoid complex there is substantial agreement, according to these various writers. For contrary to what is to be found in the Chelonia—where the remains of the hyoid arch proper is followed by two branchial bars considerably developed—the Lacertilia are generally believed to be characterised by the preservation in the adult of only one visceral arch following the hyoid arch, which is stated to be the first branchial. This statement occurs at any rate in such authoritative textbooks

\* Zool. Jahrb. (Abth. f. Anat.) vii. p. 545.

† Morph. Jahrb. xxvi.

‡ Reptilia, Bd. vi. Abth. iii. Taf. 72. figs. 2-8, & Taf. 107. figs. 24, 33.

§ E. g., *Gecko mauritanicus*, Gadow, Phil. Trans. 1888 B, pl. 72. fig. 10; *Holoderma suspectum*, Shufeldt, P.Z.S. 1890, pl. xviii. fig. 6; *Chlamydosaurus* and *Physignathus*, Beddard, P.Z.S. 1905, vol. i. p. 20, text-fig. 9, and p. 21, text-fig. 10.

as those of Hatchett Jackson\*, Gadow†, and Sedgwick‡, which may be regarded as expressing the current knowledge of the subject. Nevertheless, the late Prof. W. K. Parker§, in describing the *adult* skull of *Lacerta agilis*, wrote as follows:—"Another bar, half as long as the first, and unossified, lies behind the first branchial above; it is *f*-shaped, with the top hooked inwards, like the lower piece; this is the upper (*br.*<sup>2</sup>), or 'epibranchial' part; it has a small snag outside its middle. Besides this, there is, on each side, a slender, slightly outbent hypo-branchial (*h.br.*); this belongs to the second branchial, and also from its length is evidently part of the *third*, neither of which chondrify, above, in the embryo." In a footnote is added the remark that "this little highly-metamorphosed Lizard has scarcely thrown aside the skeleton of these organs of aquatic respiration." It is obvious that Prof. Parker's account is a little misleading, and this doubtless accounts for the fact that the existence of remains of a second branchial arch in *Lacerta* has been largely ignored in zoological literature. What he speaks of as an "epibranchial," without determining to which arch it belongs, but letters "*br.*<sup>2</sup>," is clearly from its position a vestige of the second branchial arch, as is plainly recognised in Prof. T. J. Parker's 'Zootomy' and in his 'Textbook of Zoology,' written in conjunction with Prof. Haswell||. The exceptional character of the hyoid complex of *Lacerta* in possessing "the epibranchial of the second branchial arch" is properly emphasised by Dr. Shufeldt¶ in reviewing existing knowledge of the Lacertilian hyoid bones.

The third postmandibular arch is, however, by no means a peculiarity restricted to *Lacerta*. It occurs in *Zonurus* in the form of a short and slender bar lying behind the well-developed first branchial bar\*\*. This bar of cartilage does not extend down to the median copula, and indeed fills a considerable distance short of it. I have examined three other Lacertilians in which this same visceral arch is represented and one in which it is not to be found: but I have not at present attempted an exhaustive research into the facts of its absence or presence among the different families of Lacertilia. I could not detect the bar of cartilage in *Chamaeleolis*, whose anatomy has been described above. It is well developed in both *Tiliqua* and *Trachydosaurus*. In the former (text-fig. 15, p. 54) it is very conspicuous, and it is not a little surprising that it has been missed, unless I have unwittingly overlooked its description somewhere. But if this be the case it is clear that its existence has escaped the writers of many textbooks.

\* 2nd ed. of Rolleston's 'Forms of Animal Life.'

† "Amphibia and Reptilia," in 'Cambridge Natural History.'

‡ 'Textbook of Zoology,' vol. ii.

§ "Development of Skull in Lacertilia," Phil. Trans. 1879, p. 616.

|| 'Textbook of Zoology,' vol. ii.

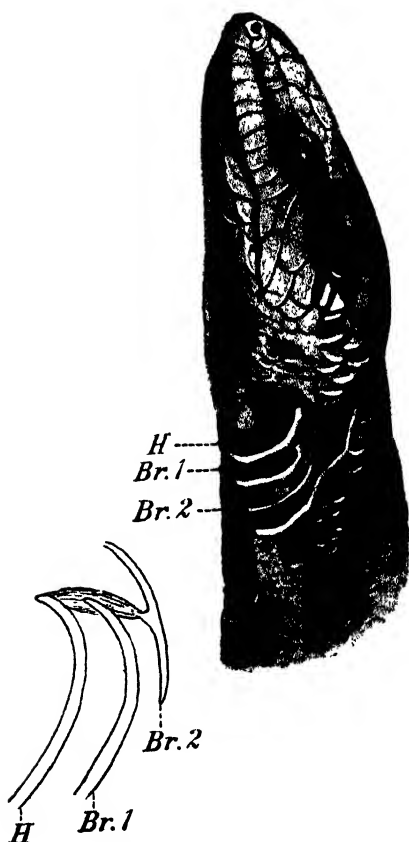
¶ P. Z. S. 1890, p. 225.

\*\* There is no trace of this shown in a figure of the hyoid of *Zonurus cordylus* copied from Henle in Bronn's 'Thierreich,' Reptilien, vol. vi. Abth. iii. Taf. 107. fig. 33.



In *Tiliqua* this second branchial arch is more extensive, as it appears, than in *Zonurus*, and lies obliquely across the first branchial arch, though beneath it. The latter arch ends in a curled piece of cartilage which is directed backwards and overlaps the third post-mandibular arch. But the position varies according to the degree of distortion of the muscles of the neck of the reptile.

Text-fig. 15.

*Tiliqua scincoides*, head and neck.

Dissected to show three postmandibular visceral arches *in situ*.

To the left the isolated extremities of the same arches in another individual.

Br. 1. First branchial arch ; Br. 2. Second branchial arch ; H. Hyoid arch.

Towards the lower end of the bar is a triangular, projecting, "snag" (not visible in one of two examples dissected) like that which Prof. W. K. Parker has figured in *Lacerta*. To this projecting process is fixed a ligament which is inserted on the free dorsal end

of the hyoid arch. The ligament thus avoids the first branchial under which it lies. It is not surprising to find that *Trachydosaurus*, so closely allied to *Tiliqua*, also possesses this second branchial arch. As in the genera mentioned, the arch is only represented by its upper part, the epibranchial, as Parker termed the equivalent cartilage in *Lacerta*. Finally, I have to record that the bar of cartilage is also found in *Gerrhonotus*, a genus of whose anatomy I offer some further notes below. In the present state of our knowledge it is not possible to state whether or not this occurrence does or does not bear upon the affinities of *Gerrhonotus*. The cartilage was not so easy to find in this small Lizard, where it is slender and delicate, but can be detected by gently moving in various directions the muscles in its vicinity; the stiff ends of the cartilage thus become apparent.

A second feature in the anatomy of *Zonurus* to which I desire to draw attention is the total absence of the gubernaculum fixing the apex of the ventricle to the walls of the pericardium. This ligamentous band or thread (it varies in importance in different genera) is so usual among the Lacertilia as to be characteristic of that order of Reptiles, as it is, indeed, of others. I have already pointed out that the gubernaculum cordis is not to be found in the heart of *Varanus niloticus* and some other species\*. It is interesting to notice that this absence of the gubernaculum which is universal in the higher Vertebrates (Aves and Mammalia), as well as generally in the Ophidia †, is sporadically developed among the Lacertilia. It should also be mentioned that this condition of the heart was found in two examples of *Zonurus giganteus* (the third was not examined *ad hoc*)‡; it is therefore probably characteristic of the species if not of the genus.

The liver of this Lizard is unusual in its form. The right lobe is prolonged in the usual way over the vena cava. But the left lobe, instead of being but slightly divided at the entry of the anterior abdominal vein, is deeply bifid thereat§. The whole organ is thus markedly trifid posteriorly and is not unsuggestive, in appearance, of the mammalian liver.

The pancreas displays one noteworthy character. Its general form is like that of the majority of Lacertilia. The organ embraces the stomach, being found on both sides of it; the splenic lobe is fairly stout and reaches the spleen, and there is a process of the gland extending towards the liver. The peculiarity of the pancreas of this Lizard is that diffuse thin ramifying tags of pancreatic tissue lie in the mesentery on either side of the splenic lobe of the gland with which they are connected. This tendency towards a diffuse irregularly shaped thin pancreas is obviously to be compared with the conditions obtaining in the Chelonia.

\* P. Z. S. 1906, vol. ii. p. 617 footnote.

† Perhaps universally also. In any case the occasional ligament tying the apex of the heart to the pericardium is rather different (see P. Z. S. 1904, vol. ii. p. 107).

‡ I have since found the same absence of the ligament in another example.

§ I am not quite certain that it is not the right lobe which is thus bifid. It is a point difficult to settle.

(5) *Some new Facts bearing upon the Affinities of*  
*Gerrhonotus.*

This genus of *Lacertilia* is sometimes placed in a special family of *Lacertilia*, the *Gerrhonotidæ*. By others (*e. g.*, Boulenger\*, Gadow†) it is relegated to the *Anguidæ*. The general aspect of *Gerrhonotus cæruleus* is, on the other hand, by no means unlike that of the *Scincidæ*; I am not aware that any notes have ever been published upon the visceral anatomy of this Lizard. I venture, therefore, to lay before the Society some notes which a recent dissection of more than one example of *Gerrhonotus cæruleus* enables me to offer as a contribution towards the determination of the systematic position of this genus or representative of a family.

I have by no means attempted an exhaustive survey of the anatomy of this Lizard. But I am able to note down a few facts, all of which are of some interest from the point of view of a comparison with other *Lacertilia*. The structure of the *quadrato-jugal ligament* is one of the characters which I carefully examined in *Gerrhonotus*. I find that the arrangement and appearance of this ligament is precisely as it is in the genus *Gerrhosaurus* and in the Skink *Eumeces*‡. That is to say, the ligament of this genus is very distinctly marked off and of equal breadth throughout, nowhere vaguely shading off into surrounding tissues. Moreover, it is attached on the one hand, of course, to the quadrate bone and on the other to the bony scales which cover the face in this region. It is not inserted on to any bone of the skull. In the present state of our knowledge it is not possible to comment upon this likeness to *Gerrhosaurus* and *Eumeces* as an argument in favour of the Skinkoid affinities of *Gerrhonotus*, though I have thought it worth while to record the fact for future comparison. The second feature in the structure to which I draw attention is the complete pigmentation of the interior of the body. There is here no paler area divided by the oviducal mesentery from a more darkly pigmented posterior portion.

As is now well known§, the umbilical ligament of the Skinks is frequently a double ligament attached to the ventral surface of the liver along two parallel lines which become confluent anteriorly. I observed nothing of the kind in *Gerrhonotus*, where the umbilical ligament is, as in most Lizards, a single mesentery. In this anatomical fact there is a likeness to *Ophiosaurus* as well as, of course, to *Iguana* and other Lizards. In any case the Lizard shows no affinities to the *Scincidæ*.

The pancreas and the spleen and their relationship to one another differ greatly among the *Lacertilia*, and more than one fact in the structure of the two glands is recorded in the present

\* Catalogue of Lizards in the Collection of the British Museum.

† "Reptilia," in 'Cambridge Natural History,' p. 538.

‡ P. Z. S. 1905, vol. ii. p. 256.

§ Beddard, P. Z. S. 1888, p. 102.

communication \*. In *Gerrhonotus* the splenic prolongation of the pancreas is present, but it does not reach the spleen at all, though extending a good way in the direction of that organ. Among the Skinks this pancreatic process towards the spleen is to be found, as I have already recorded †, in the genus *Tiliqua*, and can confirm in all details from a subsequently examined example of that genus.

There is, however, no particular likeness in the structure of the pancreas of *Gerrhonotus* to that of *Ophisaurus* ‡. In the latter the pancreas consists only of two closely applied lobes which rest upon the ventral surface of the pylorus and small intestine, there is no vestige of a splenic lobe §. The spleen of *Gerrhonotus* is rather peculiar in position. Very generally among the Lacertilia this blood-gland is elongated and somewhat bean-shaped in outline, and lies with its long axis parallel with the long axis of the stomach. In *Gerrhonotus* the shape is quite normal, but the long axis is perpendicular to the long axis of the stomach.

The hepatic portal system of veins of *Gerrhonotus cæruleus* varied but little in the two specimens dissected. The ventral parieto-hepatic veins running in the umbilical ligament were three in each Lizard. The first two crossed each in their course in one specimen, and perhaps in both, though I have no note as to this in the second example dissected. The crossing is such that the anterior of the two vessels draws blood from a region of the ventral body behind that which is supplied by the posterior of the two veins.

The dorsal parieto-hepatics are either two or three and are otherwise quite normal in their position. The arrangement of the gastro-hepatic veins is interesting in relation to the question of the affinities of the genus *Gerrhonotus*. There are either four or five of these vessels of somewhat varying calibre arranged close together, and thus forming a ladder-like structure lying quite at the anterior end of the liver and running to this from the adjacent border of the stomach. There are no gastro-hepatic veins situated more posteriorly. The interest attaching to this arrangement of the vessels is that it is completely paralleled in *Ophisaurus apus* ||, making allowances for the greater elongation of the liver in the latter snake-like Lizard.

In *Ophisaurus*, in fact, there are six of these veins. Now, as a rule, the Lacertilia have not a great many separate gastro-hepatic vessels. I have myself examined several species embracing as many genera and find the following facts, some of which I have

\* Cf. pp. 48 & 55.

† P. Z. S. 1905, vol. ii. p. 262.

‡ In contrast to this difference in form between the pancreas of genera which appear to be allied is the close resemblance in another case which I take this opportunity of recording. In both *Iguana tuberculata* and *Liotemnus magellanicus* (I owe the specimen to the kindness of my friend Capt. Richard Crawshaw), which are both Iguanidae, but not much alike superficially, the long splenic lobe of the pancreas just touches the posterior end of the spleen.

§ See P. Z. S. 1905, vol. ii. p. 475, text-fig. 64 p. *Anguis* also lacks the splenic lobe.

|| See P. Z. S. 1905, vol. ii. p. 475, text-fig. 64.

already made known in recent communications to the Society upon the anatomy of these Reptiles. In *Iguana tuberculata* I found in two examples two gastro-hepatic veins, and precisely the same arrangement characterised two examples of *Amphibolurus barbatus*. *Uromastix acanthinurus* showed, also in two examples, a single vein, which, however, was made up of three considerable affluents from the stomach; these, it will be understood, entered the liver as a single vessel. In one of the specimens the third affluent only joined the common trunk formed by the other two just before their entrance into the liver. In *Gerrhonotus*, *Tupinambis*, *Chamaeleon*, *Phelsuma*, *Tarentola*, I have recorded, or am now able to record, the existence of only one gastro-hepatic vein, which however is, as a rule, made up of two affluents. The Scincidae form an exception to the general arrangement of these vessels, and at first sight appear therefore to be near akin in this particular to *Gerrhonotus*.

Of *Tiliqua scincoides* I have dissected two examples for the purposes of the present investigation, and find in both of them the following arrangement of the gastro-hepatic veins. There are four of these, which appear at first sight to lie accurately side by side in the gastro-hepatic mesentery. A more careful examination, however, shows that the stomach is bound to the liver by two mesenteries, one above the other, as seen when the animal is opened along the median ventral line and the viscera examined in an undisturbed condition. The lower of these, *i. e.* that which lies above in the ordinary position adopted in dissection, is the gastro-hepatic mesentery found in all Lizards. When this is cut through a second mesentery comes into view, which is attached to the right side of the liver and to the more dorsal side of the stomach. This mesentery exists in other Saurians, but is inserted on to the mesogastrium and does not touch the stomach at all. Whether this arrangement of the right dorsal suspensory ligament of the liver has anything to do with the double umbilical ligament of the same family of Lizards is not certain; but it is found in most but not in all Skinks. I find it in the genus which we are now considering, in *Seps* (*Chalcides*), *Scincus*, *Eumeces*, and *Macroscincus*. It is not to be found in *Trachydosaurus rugosus*. To revert to the gastro-hepatic veins in *Tiliqua scincoides*, the most posterior of the four veins runs along the right or lower (as seen on dissection) gastro-hepatic mesentery; in front of it are two of the veins which run in the upper or left gastro-hepatic mesentery (the mesentery present in all Lizards). Finally, there is a single vein which is inserted just at the junction anteriorly of the lines of attachment of the two mesenteries, to the lower (dorsal) surface of the liver. In *Trachydosaurus*, which, although a member of the family Scincidae, agrees with other Lizards in the presence of only one gastro-hepatic mesentery, I find in an example dissected only one gastro-hepatic vein, which, as is so usual, is formed by two equally sized affluents. I have some notes, however, of an example, dissected a good many years ago,

in which in addition to this there was another vein further forward at the junction of the two dorsal suspensory mesenteries of the liver. *Macroscincus* is normal—for a Skink—in the presence of two gastro-hepatic mesenteries; and yet it has only one gastro-hepatic vein. This is formed of two equisized affluents, and runs in the right-hand mesentery, the other being quite anangious.

*Eumeces algeriensis* shows the same double series of gastro-hepatic veins that are to be found in *Tiliqua scincoides*. There is one vein only in each of the two gastro-hepatic ligaments and a third vein implanted at the junction of these anteriorly. As in *Tiliqua*, the medianly situate vein of the three belongs to the left-hand ligament. Of an example of *Chalcides ocellatus*, dissected by me a good many years ago, I have sketches and descriptions showing that this species is more like *Macroscincus*\* than *Eumeces* or *Tiliqua*. For the gastro-hepatic veins are limited to the right-hand one of the two gastro-hepatic ligaments, with the usual vein which enters the liver at the junction of the two veins. There were in this individual four of these veins in the right ligament. It seems, therefore, that the numerous gastro-hepatic veins of the genus *Gerrhonotus* may be regarded as evidence of affinity with the Anguidæ, since these veins are, as a rule, not numerous among the Lacertilia other than the Anguidæ, Amphisbænidæ, and *Hatteria*, except among the Scincidæ, where the existence of two gastro-hepatic ligaments accounts for the greater number of these veins than occurs in the majority of those genera with only one gastro-hepatic ligament. And, in coming to this conclusion, it must be further borne in mind that the number of gastro-hepatic veins would appear to be fairly constant, so far as the somewhat meagre facts already known allow us to judge. There is but little else in the anatomy of this Lizard, so far as I have been able to record the facts, which bears very distinctly upon its affinities, a conclusion for which the, at present, very small knowledge of the Lacertilia is doubtless largely responsible. It seems, at any rate, to be the fact that *Gerrhonotus* exhibits no marked features in its organisation which point to an affinity with the Scincidæ, except perhaps the condition of the quadrato-jugal ligament, which is undoubtedly like that of *Eumeces*.

(6) *On a Point of Structural Resemblance between Heloderma and Varanus, and on some Specific Characters of Varanus.*

Although it is not the prevalent opinion that these two genera of Saurians are nearly allied, there are not wanting anatomical resemblances between them; and, indeed, some of the most recent writers † on the anatomy of *Heloderma* have brought together a

\* It is perhaps not without interest to notice that in these two genera (*Chalcides* and *Macroscincus*) the double character of the umbilical ligament is not so marked as it is in *Eumeces* and *Tiliqua*. They have, therefore, at any rate, two anatomical features in common.

† Boulenger, P. Z. S. 1891, p. 109; Beddard, *ibid.* 1906, vol. ii. p. 601.

good many facts in favour of such an alliance. On the other hand, Dr. Shufeldt \*, who has given us a comprehensive sketch of the anatomy of *Heloderma*, remarked that his own studies of the Varanidæ convinced him "of the fact that *Heloderma* is far removed from that group, having very little structural affinity with it." To these papers cited below, and to others quoted in them, reference may be made for the views which have been held with regard to the position occupied by the genus *Heloderma* in the system.

In recently dissecting examples of these two genera I have noticed two structural features in which the two genera are similar and by which they may be differentiated from any other Lacertilians whose anatomy is known, so far as concerns the points in question. The first of these is a feature in the anatomy of the respiratory organs which has indeed been described in *Varanus* but not in *Heloderma*. As to the former genus, Meckel †, Günther ‡, and Milani §, to whose investigations our knowledge of the anatomy of the respiratory organs in the Varanidæ is chiefly due, describe a short branch given off by the bronchus shortly after it has entered the lung; this supplies the headward extension of the lung which is so well marked in this genus of Lizards. It is plainly figured by Milani ||, whose illustrations ¶, particularly a diagrammatic figure, show that this twig arises in front of an aperture in the walls of the intrapulmonary bronchus. Some of Milani's figures \*\* also illustrate another somewhat important fact, which is that the bronchus until it gives off the branch to which reference has been made does not really lie within the lung, but outside of it. The lung in growing forward has wrapped round the end of the bronchus. Though apparently within, this portion of the bronchus is really morphologically outside of the lung. The interest attaching to the exact relationship between the bronchus, the lung-tissue, and the first branch of the bronchus appears to me to be this:—that this independent branch arising so early from the bronchus is possibly to be compared with the eparterial bronchus of the Mammalia. This comparison is not suggested by Milani. In any case it is, so far as I am aware, a structure that has not yet been described in any other Lacertilian. A precisely comparable branch of the bronchus occurs, however, in *Heloderma*, where its existence is an interesting feature of resemblance to *Varanus*. I cannot find that any of the writers †† who have described the lung of *Heloderma* have noticed this—to my eyes, very striking—peculiarity of the lung. Nor do the illustrations given by them show any signs of the

\* P. Z. S. 1890, p. 233.

† Deutsches Arch. f. d. Phys. 1818, Bd. iv.

§ Zool. Jahrb. (Abth. f. Anat.) vii. 1894, p. 581.

|| Loc. cit. Taf. 31. figs. 16–18.

¶ Loc. cit. p. 581, fig. R, Taf. 32. figs. 19–21.

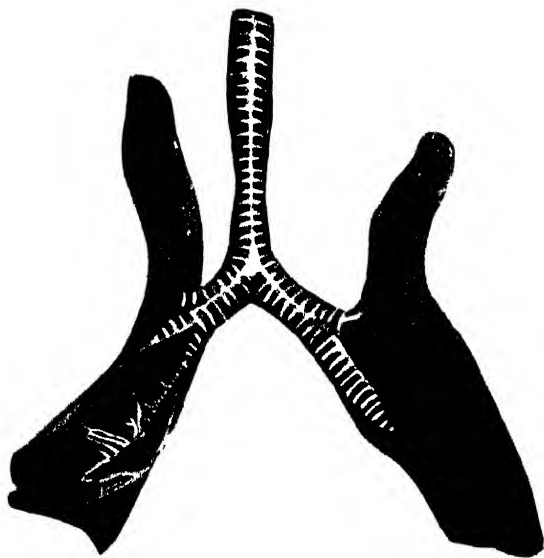
\*\* Especially fig. 20 of pl. 32 of his memoir.

†† Shufeldt, loc. cit. p. 202; Stewart, P. Z. S. 1891, p. 118; Miller, "The Structure of the Lung," Journ. Morph. viii. 1893, p. 170.

‡ P. Z. S. 1861, p. 112.

eparterial bronchus in *Heloderma*. The length of the bronchi and the complicated structure of the lungs themselves have, however, been remarked upon, and in these matters *Heloderma* also agrees with *Varanus*. The figure (text-fig. 16) shows the commencement of the lungs in *Heloderma suspectum* as seen from the dorsal aspect. The long headward prolongation of each lung, not perhaps sufficiently emphasised in Dr. Shufeldt's figure of these organs, is very reminiscent of *Varanus*. The rings of the trachea are, as correctly stated by Shufeldt, incomplete in the dorsal median line. The bronchi are described by the same writer as "unusually long"; but it is not clear from

Text-fig. 16.



A portion of the trachea, the bronchi, and the upper parts of the lungs of *Heloderma*, from the dorsal side.

The left lung cut open to show the course of the bronchus within it.

the description given, as Prof. Stewart\* has pointed out, that this great length does not apply to the intrapulmonary portion of the bronchus. My own measurements of the length of the bronchus up to the place at which it enters the lung agree with those of Prof. Stewart in the case of *Heloderma horridum*. I find this length, in fact, to be as nearly as possible 13 mm. To be absolutely exact is impossible, on account of the pliability of the bronchial rings and interspaces. The bronchi of *Heloderma* are therefore shorter than those of *Varanus* (text-figs. 18 & 19,

\* P. Z. S. 1891, p. 120.



pp. 65, 66), and not very much longer than those of a similarly-sized *Iguana tuberculata*. Generally speaking, it is undoubtedly correct to describe the Lacertilia as possessing short bronchi, to which rule, indeed, *Varanus* offers the only very marked exception. The relations of the bronchi to the lungs are not shown in Shufeldt's figure\*, where the heart obscures the same, and are wrongly shown in the figure of Miller†. The latter author is wrong (unless, indeed, the lungs of *Heloderma suspectum*, examined by myself, are abnormal) in not indicating, in the figure referred to, a conspicuous branch of the bronchus developed equally on both sides of the body. When the trachea divides, the dorsal median fibrous wall lying between the disjunct ends of the tracheal semirings is continued down each bronchus. As Dr. Shufeldt has remarked, the calibre of each bronchus is not far short of that of the trachea itself. They are, in fact, particularly wide. The ends of the bronchial semirings are, of course, visible on either side of the median fibrous tract. The bronchus approaches the lung and becomes adherent to its mesial side and runs down in contact with it for some distance until it finally enters the lung. At the point of contact the upper ends of the semirings, *i. e.* those lying headwards, cease to be parallel with the lower ends and diverge headwards. The dorsal membranous space ceases, and the semirings in that section of the bronchus which is closely applied to the lung embrace the lung. There is, in fact, a branching of the bronchus, and this short branch may be seen to be lined by cartilaginous semirings for a short distance into the interior of the lung. This is not the case with the following apertures of communication between the bronchus and the lung. I cannot but think that this branch is comparable to that already referred to in *Varanus*. It is further not without importance to notice that this "eparterial bronchus" in *Heloderma* is not serially comparable to the apertures which place the cavity of the bronchus into communication with the interior of the lung and which follow it. For the latter are more ventral in position, as is plainly to be seen in the accompanying figure (text-fig. 16). The "eparterial bronchus" is more dorsal and is, in fact, lateral with reference to the main stem of the bronchus.

The figure (text-fig. 16) which illustrates the branching of the bronchus before entering the lungs also shows on the left side the interior of the lung as seen when the bronchus is slit up after it has given off the branch referred to. I have thought it worth while to introduce this view of the lung of *Heloderma*, since the figure given by Miller‡ does not appear to me to represent quite accurately the mode of communication between the interior of the bronchus and the lung-substance, nor does he indicate the adherence of the bronchus to the lung for a considerable distance before entrance. He does, however, illustrate the important fact

\* *Loc. cit.* pl. xvi. fig. 3.

† *Journ. Morph.* 1893, pl. vii. fig. 5.

‡ *Loc. cit.* pl. vii. fig. 5.

that the bronchus traverses a considerable distance within the lung before it disappears. My own illustration will show that the semirings of the bronchus are complete for a considerable distance, and perfectly easily recognisable, since they show no particular differences from the semirings in the extrapulmonary region of the bronchus. The bronchus communicates with the lung by copious apertures, which are not situated in the region of the bronchus corresponding to the fibrous band which unites the tips of the semirings in the extrapulmonary region of the lung; these apertures would seem to be rather breaks in continuity of the semirings themselves. Their disposition is thus reminiscent of the way in which the rudimentary lung of certain Snakes arises from the bronchus. There is a simple hole in the bronchus which leads into the lung in the case of those Snakes.

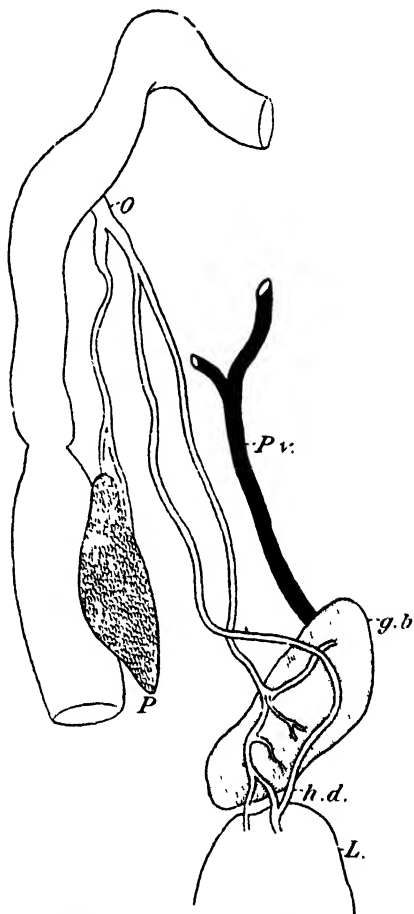
In a paper communicated to this Society a good many years since\* I described the complicated branching of the cystic duct and its anastomosis with the hepatic duct in *Varanus salvator*. I have since then discovered that the same network, comparable to that which is found so generally among the Ophidia, occurs also in *V. gouldii*, though it is in that species rather less developed than in *V. salvator*. Quite recently I have dissected out the bile-ducts in *V. niloticus*, of which species I have had the opportunity of examining several very small examples preserved in spirit. I had one of these injected from the gall-bladder, and the injection (chrome-yellow rubbed up in olive-oil) ran readily along the branches of the cystic and hepatic ducts. The accompanying figure (text-fig. 17, p. 64) is fairly accurate (but I fear not absolutely so) as regards the network, which, as will be seen, is much like that of *V. salvator*, but perhaps not quite so complicated. Moreover, when once the hepatic and cystic ducts have left the surface of the gall-bladder there are apparently no further anastomoses between them, as there are—though to a limited extent—in *V. salvator*. On the other hand, there are some species of *Varanus* in which there is no network formed by the bile-ducts on their emergence from the gall-bladder (as is also found among the Ophidia). To some of these I have referred in my communication just quoted. I have since carefully examined *Varanus exanthematicus*, and find that the cystic duct emerges as, and continues to be, a simple duct throughout. The same is the case with *V. griseus*. It is not wise perhaps to generalise on these few data; but so far as the facts go they agree with an important external character by which the species referred to may be grouped. In *V. salvator*, *V. gouldii*, and *V. niloticus* the nostril is a circular aperture, while in the other species mentioned it is obliquely placed and slit-like.

In all the species of *Varanus* that have been referred to in the

\* P. Z. S. 1888, p. 106. The illustrative figure (fig. 4, p. 106) has been copied in Gegeubaur's 'Vergl. Anat. Wirbelth.'

present communication the pancreas is a solid body, as shown in the figure of that of *V. niloticus* (text-fig. 17). In all of them a

Text-fig. 17.



Pancreas, gall-bladder, &c. of *Varanus niloticus*, to show the course of the bile-ducts.

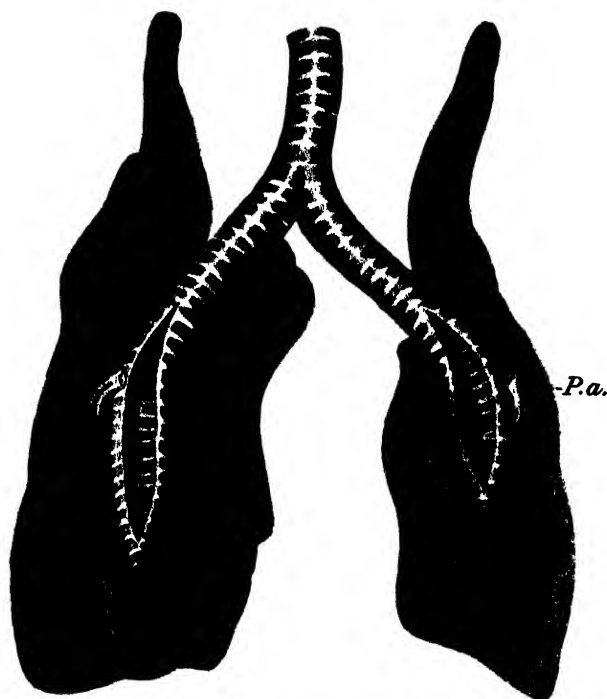
*g.b.* Gall-bladder; *h.d.* Hepatic ducts; *L.* Liver; *O.* Orifice of conjoined bile-ducts; *P.* Pancreas; *P.v.* Portal vein.

very slender splenic lobe arises near to the anterior end of the pancreas and passes to the spleen\*. The species, however, show

\* In *Varanus exanthematicus* the end of the splenic not merely touches, but enwraps and is enwrapped by the spleen. This intimate relation between the spleen and the pancreas recalls a similar close association occasionally found among the Ophidia.

certain differences among themselves in the position of the duodenum with reference to the pancreas. In *V. niloticus* the pancreas is separated by a considerable tract of mesentery from the duodenum, which results in the exposure of a long pancreatic duct. The same is the case with *V. ocellatus*. On the other hand, in *V. griseus* and *V. exanthematicus* the end of the pancreas touches the duodenum close to the point of entrance of the pancreatic and bile ducts, and there is therefore no great length of pancreatic duct.

Text-fig. 18.

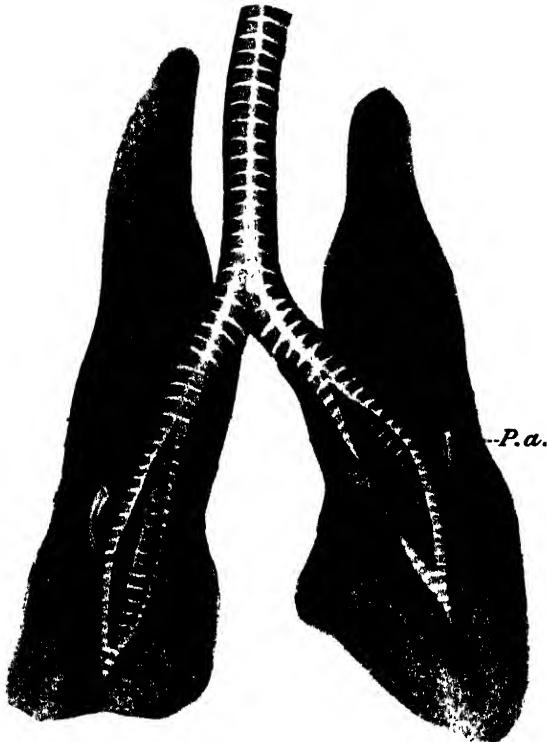
Lungs of *Varanus exanthematicus*.

Bronchi opened to show exit of "eparterial bronchi" close to pulmonary artery (*P.a.*).

In his figures of the lung of several species of *Varanus*, Milani has pointed out certain differences which distinguish them. Thus the lungs of *V. bengalensis* are lobed externally in a fashion which is not to be found in the other species which are described. In examining, for the purposes of the present communication, the lungs of several species of *Varanus*, I have observed two small points of difference between the lungs of certain species which are not referred to by Milani. Of these both involve an asymmetry

or symmetry of the lungs and the windpipe as the case may be, not, indeed, in point of length, which is a common feature among Lizards and one of the most obvious features in which they approach the Snakes. This asymmetry, when it occurs, affects the position of the "eparterial bronchus" and the ventral forward projection of the lung between the bronchi. In *Varanus griseus* (text-fig. 19) the left lung, as well as the right lung, sends forward towards the bifurcation of the bronchi a thin diverticulum, which has an entire cavity not divided by any meshwork and seems to be comparatively unvascular. This can readily be lifted up and is seen to be not attached to the bronchus of the lung of which it is an outgrowth.

Text-fig. 19.



Lungs of *Varanus griseus*. Details as in text-fig. 18.

So far, therefore, the lungs are symmetrical. But the origin of the eparterial bronchus is not symmetrical. On the right side this branch arises from the bronchus at a distance of 27 mm. from the point of bifurcation of the bronchi; in the case of the left

lung this distance was only 21 mm. A second specimen showed precisely the same relations in all these points of structure. Contrasted with this (compare text-figs. 18, 19) are the different conditions observable in *Varanus exanthematicus*. In the latter species (text-fig. 18, p. 65) the two branches of the bronchi were exactly symmetrical and each was situate 33 mm. from the bifurcation of the bronchi. Only the right lung gave off a forwardly directed lobe situated on the inner side of its bronchus. There was nothing to correspond in the left lung. I have not been able to compare these conditions with those of many other species of *Varanus*. But in both *V. ocellatus* and *V. niloticus* there was precisely the same asymmetry in the relative positions of the branch of the bronchus, which in all cases lies behind the aorta of its side.

*Summary of more important new Facts contained in this  
Communication.*

In view of the fact that very few genera and species of Lacertilia have been studied anatomically, it is a little difficult at present to differentiate between more and less important structural details as evidence of affinities between different genera. The following *résumé*, therefore, will be necessarily only an attempt to lay stress upon what appear at present to be the more important new facts which I have set forth in this communication.

(1) The *pancreas* in the Lacertilia, as already known, differs in different genera. I have added to the existing knowledge some new facts with regard to genera and species not examined by others. It appears from this that the chief variability in the pancreas consists in the presence or absence of a splenic lobe and in the relations of the latter to the spleen. The classificatory importance of the facts does not appear to be great; since, though the Iguanoids, *Iguana* and *Liolaemus*, are like each other in the relations between the splenic lobe of the pancreas and the spleen, we find in *Varanus* and *Chamaeleon* differences between different species in these points. The pancreas is nearly always a compact gland; but not so in *Zonurus*.

(2) The variations in the structure of the viscera among the Chamaeleons concern principally the proportions between the two lobes of the liver, the form of the diverticula of the lungs and the absence or presence of these, the degree of pigmentation of the body-cavity, and the degree of coiling of the intestines.

(3) The variations in the structure of the viscera in the different species of *Varanus* concern principally the presence or absence of a bile-duct network and certain minute differences in the lungs. It seems possible that those species with a round nostril are distinguished from those with an oblique slit-like nostril by the possession of this network.

(4) The simplicity of structure which is often associated with small-sized forms as compared with their allies of larger size is

well seen in the two small species of Chamæleons, viz. *Ch. pumilus* and *Ch. tæniobronchus*, where the lungs have no diverticula and the intestinal tract is nearly straight.

(5) The very general presence of a gubernaculum cordis among the Lacertilia renders its absence in *Zonurus* a matter worthy of comment.

(6) The most important fact, perhaps, which I have been able to ascertain is the persistence in several genera of Lacertilia of considerable remains of the fourth visceral arch (second branchial). This is a fair-sized bar of cartilage which does not make any connection with the copula below. The existence of this arch has, however, been recorded in the adult *Lacerta* by the late W. K. Parker.

(7) The two genera *Varanus* and *Heloderma* (which are quite remote from each other in some structural features) agree with each other in that each bronchus is adherent to its lung for some little distance before it enters it, and emits a short branch to the upper end of the lung before it becomes confluent with the lung.

(8) It is interesting to note the double gastro-hepatic membrane in certain Scincidæ, which is associated with a correspondingly double set of gastro-hepatic veins, as distinctive of that family, though not universal.

#### 4. A List of Moths of the Family *Pyralidæ* collected by A. E. Pratt in British New Guinea in 1902-3, with Descriptions of new Species. By GEORGE H. KENRICK, F.Z.S.

[Received December 8, 1906.]

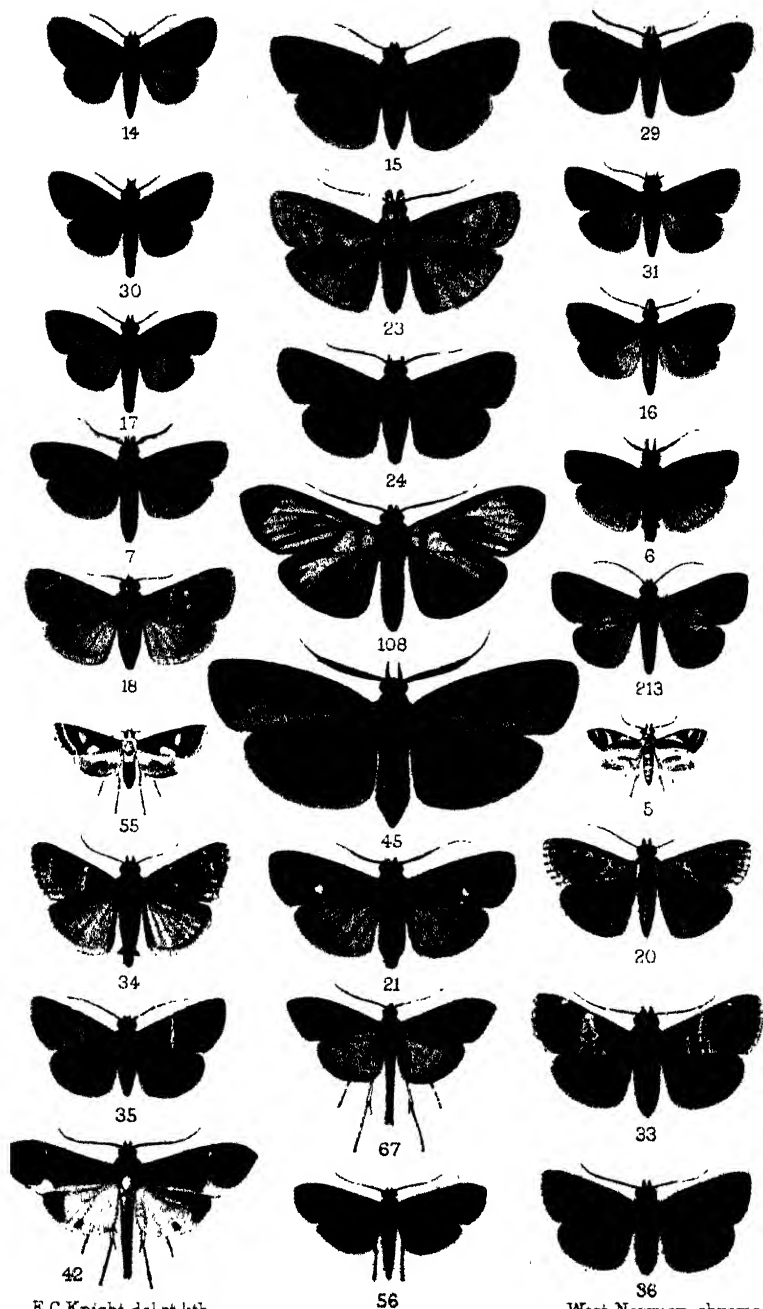
(Plates III. & IV.\*)

This collection was made under circumstances mentioned by Mr. Pratt in his book 'Two Years among New Guinea Cannibals,' published in 1905, and beyond the fact that most of the specimens were taken at light very little information can be given.

The country in which the collections were made appears in some of its characters to resemble Darjiling: there are the same precipitous ridges with narrow valleys between, all with a background of snowy mountains of great elevation, and everywhere there is much dense forest. The climate, with its abundant rain in the wet season and brisk air in the dry season, is also similar, while an abundant lepidopterous fauna completes the resemblance.

Although most of the insects were taken at light, in most cases females were well represented and the condition of the insects is extremely good.

\* For explanation of the Plates, see p. 87.



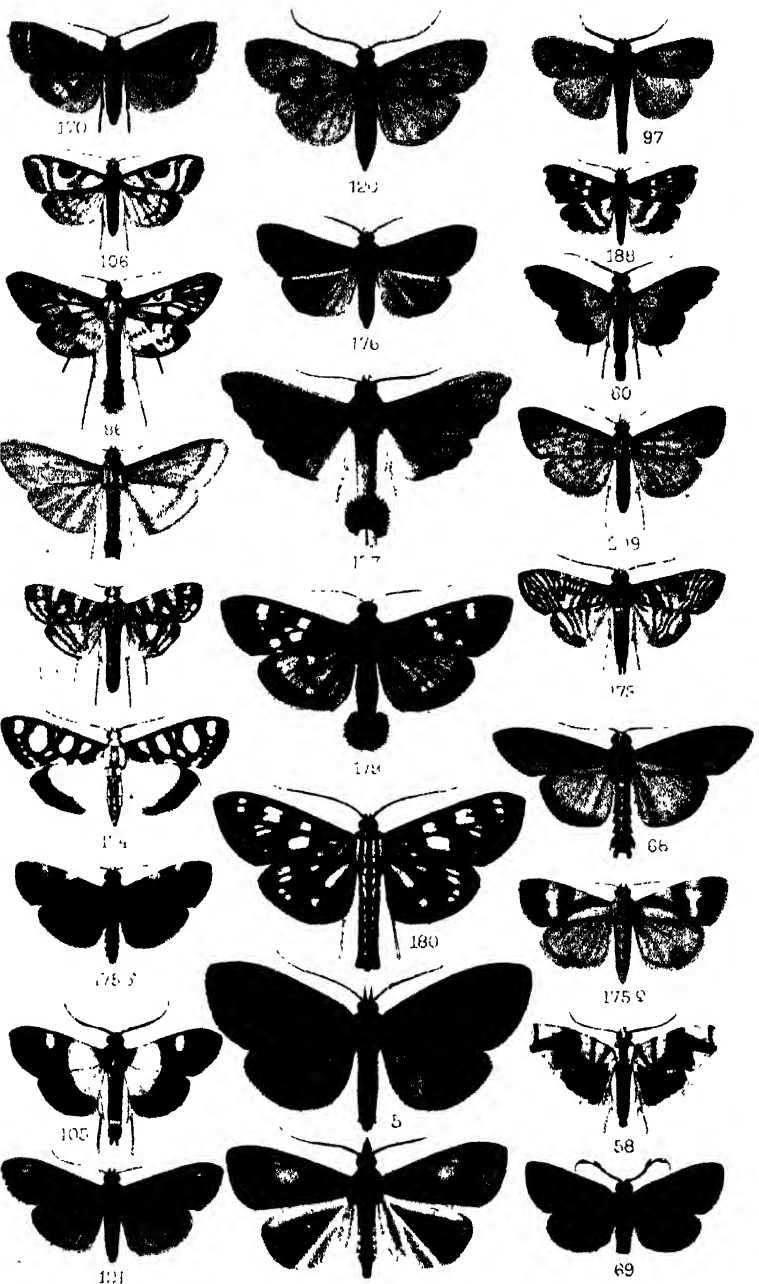
E.C. Knight del et lith

West, Newman chromo.

PYRALIDÆ FROM BRITISH NEW GUINEA.







E.C. Knight del et lith

West. Newman chrom

PYRALIDÆ FROM BRITISH NEW GUINEA.



## Subfam. SCHÆNOBIINÆ.

1. CIRRHOCRISTA ÆTHERIALIS Led.
2. C. PULCHELLALIS Led.
3. C. FIGURATALIS Wlk.
4. C. CACONALIS Swinh.

## MONODONTA, gen. n.

Palpi porrect, more than length of head, parallel, clothed with hairs, but very thin; antennæ simple; patagia shorter than thorax. Venation of fore wing: veins 2 and 3 before end of cell, 4 and 5 from end of cell, 6 and 7 from end of cell, curved and nearly parallel, 9 and 10 from cell. Hind wing: cell rather short; veins 2 and 3 before end of cell, 4 and 5 from end of cell, 6 from upper angle, 7 anastomosing with 8 halfway between end of cell and end of wing; costa slightly curved; hind margin convex, rounded at angle.

Type, *M. passalis*.

5. MONODONTA PASSALIS, sp. n. (Plate IV.)

Head, legs, thorax, and patagia dark brown, abdomen rather paler. Fore wing pale brown inclined to purplish, an oblique dark line at one-fifth of the length of the wing, followed by a much darker portion outwardly bounded by a curved dark line deeply notched near angle of wing, this is followed by a pale ochreous shade. Hind wing pale ochreous at base, shading into darker towards the margin and having an indented dark line similar to that of the fore wing; fringes darker.

Exp. 50 mm.

Hab. Kebea, one specimen.

## Subfam. PHYCITINÆ.

6. PHYCITA DINAWA, sp. n. (Plate III.)

Head, legs, palpi, and body ochreous, darker above. Fore wing marbled with purple, green and gold, the raised scales beyond the cell darker; a curved postmedian line dark margined with paler. Hind wing plain purplish grey. Fringes of fore wing purple; fringes of hind wing paler.

Exp. 24 mm.

Hab. Dinawa, four specimens.

7. ETIELLA FUSCALIS, sp. n. (Plate III.)

Head, legs, palpi, and body brown with numerous pinkish hairs. Fore wing pinkish brown, a darker brown mark two-thirds along the inner margin edged on either side with paler; fringes dull pink. Hind wing smoky grey; fringes same colour.

Exp. 28 mm.

Hab. Dinawa and Kebea, four specimens.

8. HYPISPYLA ROBUSTA Moore.

## Subfam. EPIPASCHINÆ.

9. *MACALLA CENOCHROA* Hmps.10. *M. PICTA* Warr.11. *M. NYCTICHOALIS* Hmps.12. *M. SEMINIVEA* Wlk.13. *M. MARGARITA* Butl.14. *M. UNIPUNCTALIS*, sp. n. (Plate III.)

Head, legs, palpi, and antennæ ochreous, tarsi barred with darker. Fore wing reddish ochreous, with wavy antemedian and postmedian lines dark brown, between them is a black spot very near costa; the outer third of the wing is brown and there is a marginal row of black dots. Hind wing much paler, with similar marginal row of black dots and a faint curved median line. Fringes ample, shining brown.

Exp. 28 mm.

*Hab.* Dinawa, one specimen.

15. *M. CARADRINIFORMIS*, sp. n. (Plate III.)

Head, antennæ, palpi, and legs ochreous, tarsi darker; thorax, patagia, and fringes all of the same colour. Fore wing ochreous, with curved and rounded postmedian line paler but outwardly margined with darker; on the costa are three equidistant badly defined, slightly darker markings; from the middle of the base of the wing is a ragged darker streak, and this becomes stronger as it approaches the postmedian line near the end of which is a dagger-like marking. Hind wing uniformly ochreous.

Exp. 32 mm.

*Hab.* Dinawa and Ekeikei.

16. *M. POMALIS*, sp. n. (Plate III.)

Head, thorax, palpi, and processes pale green, tibiae barred with pale green and brown; eyes black with a network of buff; abdomen green above, buff below. Fore wing apple-green with irregular markings of dark chestnut; a transverse band at one-third length of wing, an irregular divided blotch on inner margin reaching nearly to the angle, and a square-shaped blotch on costa near, but not at, the tip of the wing; a dark spot at end of cell. Hind wing pale brown; fringes paler.

Exp. 24–26 mm.

*Hab.* Dinawa.

17. *M. CURTULALIS*, sp. n. (Plate III.)

Head, antennæ, palpi, and legs pinkish buff, tarsi ringed with darker. Fore wing wainscot-colour with a conspicuous chocolate

tip; three dots on costa before this mark and a dot at end of cell. Hind wing pale clouded on margin with smoky.

Exp. 23-26 mm.

Hab. Dinawa.

18. *M. APICALIS*, sp. n. (Plate III.)

Head, antennæ, and palpi chestnut, thorax and abdomen the same with a few grey hairs; patagia paler. Fore wing: ground-colour chestnut, but the band, which is conspicuously white, is extended in some specimens in a tooth into the hind margin while on the other side it produces a basal blotch. Hind wing fuscous edged with darker. Fringes of both wings pale chestnut.

Exp. 30-34 mm.

Hab. Kebea, Dinawa, Babouni, Ekeikei.

19. *M. TENEBROSALIS*, sp. n.

Head, legs, palpi, and antennæ ochreous; abdomen grey, with dark transverse band on second segment. Fore wing ochreous with basal and apical blotch; the band begins near the base with a dark interrupted line, it is twice as wide on costa as on inner margin and the exterior boundary is an oblique angulated dark line; the interior of the band is reddish ochreous with a dark dot at end of cell. Hind wing smoky. Fringes of both wings ochreous.

Exp. 32-36 mm.

Hab. Kebea, Ekeikei, Babouni.

20. *M. PERDENTALIS*, sp. n. (Plate III.)

Head, legs, palpi, and antennæ pinkish; thorax, patagia, and abdomen ochreous grey, with a slight chestnut band on second segment. Fore wing ochreous grey with dark lines and chestnut patches, basal blotch grey; band very irregular, bounded on inner side by an oblique dark angulated line, on outer side by a strongly marked line, very narrow on inner margin but occupying about one-third of costa and mostly chestnut; beyond the band is a darker cloud towards apex; there is also a dark central dot. Hind wing smoky with darker veins, rather paler towards the base. Fringes of both wings pale grey.

Exp. 30 mm.

Hab. Dinawa, Kebea.

21. *M. PORPHYREALIS*, sp. n. (Plate III.)

Head, legs, palpi, and antennæ pinkish ochreous; thorax grey to reddish. Fore wing mostly dark brown, with whitish and grey interrupted transverse bands; the median band is very indistinct but its outer boundary is marked by a paler narrow angulated band with a tooth in the middle; there is a row of subterminal dark spots. Hind wing straw-colour with darker margin. Fringes of both wings pale.

Exp. 34-36 mm.

Hab. Ekeikei, Kebea, Dinawa.

All the species of *Macalla* enumerated above exhibit considerable colour variation and in most cases a certain amount of sexual variation as well. It is quite possible that when they are better known some may prove to be varieties; on the other hand, it is also possible that some now treated as varieties may turn out to be veritable species.

22. *POLYLOPHOTA BARBAROSSA* Hmps. n.

23. *P. TRUNCALIS*, sp. n. (Plate III.)

Top of head, antennæ, palpi, legs, and thorax pale buff with some black hairs; patagia black. Fore wing buff with a darker cloud near the angle and an interrupted subterminal double line; a subtriangular dark mark extends from near the base along the costa gradually thinning out; in the midst of this is the transverse brush of raised scales nearly black. Hind wing reddish with dense rufous hairs near body. Fringe of fore wing very dark; fringe of hind wing reddish. Tibiæ of hind legs clothed with rufous hairs.

Exp. 38 mm.

*Hab.* Dinawa.

24. *LOCASTRA CASTANEALIS*, sp. n. (Plate III.)

Head, legs, antennæ, and palpi pale chestnut; tarsi ringed with darker; thorax and patagia chestnut, abdomen paler. Fore wing chestnut, the first third suffused with grey near the inner margin, after this comes a dark transverse angulated line forming the inner boundary of the band, the outer boundary of which is a curved pale transverse line; at the angle of the wing is a conspicuous grey elliptical blotch. Hind wing grey; fringes paler.

Exp. 36 mm.

*Hab.* Dinawa.

25. *STERICTA SPORETA* Turn.

26. *S. HARRALDUSALIS* Wlk.

27. *S. PRASINA* Wait.

28. *S. DIVITALIS* Guen.

29. *S. FLAMMEALIS*, sp. n. (Plate III.)

Head and palpi greenish, antennæ and legs pink, tarsi barred with darker, thorax and process greenish; body pinkish. Fore wing: ground-colour dark olive-brown; at one-third distance along the costa is a broad transverse band and at one half a distinct angulated but narrower band; these markings and a portion of the wing near the hind margin are of pale olive-green. Hind wing rich golden orange. Fringes of both wings orange-pink.

Exp. 26 mm.

*Hab.* Ekeikei, one specimen.

30. *S. CORNUCALIS*, sp. n. (Plate III.)

Head, palpi, antennæ, legs, and thorax rufous buff. Fore wing buff with darker and lighter lines and dots; on the costa a dark mark at base and another at one-third length of wing, smaller dots at one half and two-thirds, a cloud at the tip; a wavy subterminal line dark edged with lighter; a dark dot on inner margin near body. Hind wing buff, with a dark wavy line edged with lighter and dark central spot; fringes buff spotted with darker.

Exp. 22 mm.

*Hab.* Dinawa.

31. *S. SUBVIRIDALIS*, sp. n. (Plate III.)

Head, legs, thorax, abdomen, palpi, and the long processes which extend to the back of the thorax, buff. Fore wing dull brown, with two transverse pale greenish bands parallel to hind margin, the first at one-half and the second at two-thirds length of wing; below the cell these bands run into a large patch of the same colour which continues along two-thirds of inner margin and projects a little beyond the second transverse band. Hind wing dull brown; fringes same colour.

Exp. 28 mm.

*Hab.* Kebea, Dinawa, Babouni.

32. *ORTHAGA VITALIS* Wlk.33. *O. POLYCHROALIS*, sp. n. (Plate III.)

Head, antennæ, legs and thorax chestnut inclining to pink; abdomen rather paler, with no band on second segment. Fore wing greenish with chestnut patches; basal blotch mingled olive and chestnut, with raised scales in longitudinal dark line, then a vertical line edged outwardly with white; the band is badly defined but there is an angulated thin line forming the external boundary; the remainder of the wing is greenish white, with a chestnut apical patch. Hind wing pale buff. Fringes of both wings pale; underside of costa of both wings broadly red.

Exp. 30 mm.

*Hab.* Dinawa.

34. *O. CHIONALIS*, sp. n. (Plate III.)

Palpi simple in both sexes, reaching vertex of head; antennæ of male ciliated and with a process consisting of an immense tuft of scales reaching over part of thorax; in the female this is very small.

Head, palpi, antennæ, and legs pinkish buff, legs ringed with paler at the joints; thorax, patagia, and process greenish; abdomen greyish ochreous. Fore wing: ground-colour dark olive-brown, basal patch with raised scales both light and dark followed by an oblique narrow white band, then follows the main band, in some



specimens suffused with white and bounded by a curved paler line after which is a darker cloud. Hind wing fuscous; fringes of both wings paler.

Exp. 38-39 mm.

Hab. Ekeikei, Baboumi, Kebea, Dinawa.

35. *ORTHAGA FUSCOFASCIALIS*, sp. n. (Plate III.)

Antennæ of male ciliated, with process roughly scaled and reaching thorax; female without process.

Head, palpi, antennæ, legs, and top of thorax ochreous; the male has a dark collar to thorax, absent in the female; abdomen ochreous. Fore wing: ground-colour fuscous; a dark basal blotch occupies one-third of the wing; the band is bounded on the inner side by a narrow vertical white band, this is followed by pale ochreous with dark dots on the costa and is bounded outwardly by a dark wavy interrupted line; the remainder of wing of the ground-colour with a row of subterminal triangular dots. Hind wing fuscous; fringes paler. In some specimens the band is suffused with chestnut.

Exp. 26-30 mm.

Hab. Dinawa and Kebea.

36. *O. COLUMBALIS*, sp. n. (Plate III.)

Head, legs, antennæ, thorax, and body dove-colour; legs ringed with black. Fore wing dove-colour, on costa at base a triangular black patch, the apex of which reaches the inner margin as a thick black line and forms the inside vertical boundary of the band; the band itself is dove-colour, but there is a thin curved black line parallel with inside boundary and an irregular black patch on vein 2; the outer boundary of the band is a curved thick black line, and beyond this on the costa is an anteapical black patch. Hind wing dove-colour; fringes paler. Underside smoky with whitish dots on costa.

Distinct from *seminivea* in absence of white thorax and black collar.

Exp. 36 mm.

Hab. Kebea, one specimen.

37. *TERMIOPTYCHA CYANOPA* Meyr.

Subfam. *ENDOTRICHINÆ*.

38. *ENDOTRICHIA ALBICILIA* Hmps.

39. *E. PERSICOPA* Meyr.

40. *COTACHENA TRIVITRALIS* Hmps.

41. *C. ALUENSIS* Butl.

## TIPULIFORMA, gen. n.

Fore wing: vein 2 present; veins 3, 4, 5 from lower end of cell; veins 6, 7 from upper end of cell; vein 7 parallel and close to 8 for one-third of its length, then turning down; vein 9 from middle of cell. Hind wing: veins 7 and 8 anastomosing. Proboscis well developed; palpi upturned reaching vertex of head, densely clothed with hairs; antennæ simple, three-quarters of the length of fore wing. Abdomen projecting for half its length beyond hind wing; legs long and slender, with small spurs on the tibiæ; fore tarsi somewhat hairy. Fore wing long and narrow; hind wing subquadrate.

42. *T. TRIANGULALIS*, sp. n. (Plate III.)

Thorax, head, and palpi grey; patagia whitish; underside quite white; abdomen grey above, white beneath, tuft white; eyes very prominent. Fore wing dark smoky-grey shot with reddish; costa narrowly buff for two-thirds of wing; a small basal spot white, followed by three other white dots along the costa; the inner margin with a narrow pale streak expanding into a quadrangular blotch at the angle. Hind wing white; a marginal dark band tapering from apex of wing and interrupted by a tooth in the middle. Fringes of both wings dark at apex and white at angle.

Exp. 36 mm.

*Hab.* Dinawa.

## Subfam. PYRALINÆ.

43. *VITESSA SURADEVA* Moore.44. *V. ZEMIRA* Cram.45. *V. GRISEATA*, sp. n. (Plate III.)

Head, thorax, and patagia pale orange, with four black dots across the front of thorax; abdomen black ringed with yellow; palpi black. Fore wing pale greenish grey; veins near the hind margin tinged with black; a vortical metallic blue streak across the base of the wing and the space between this and the body dull orange, with one blue spot and a blue oblique streak below it; fringes same colour as fore wing. Hind wing black; fringes paler.

Exp. ♂ 51 mm., ♀ 66 mm.

*Hab.* Dinawa.

46. *HYPSOPYGIA POSTFLAVA* Hmps.47. *SACADA INORDINATA* Wlk.48. *S. NIGROPUNCTATA* Hmps.

## Subfam. HYDROCAMPINÆ.

49. *CYMORIZA USTALIS* Wlk.  
50. *AULACODES PLICATALIS* Wlk.  
51. *A. GONIOPHORALIS* Hmps. n.  
52. *A. ACROPERALIS* Hmps. n.  
53. *A. DIOPSALIS* Hmps. n.  
54. *A. TRICHOCERALIS* Hmps. n.  
55. *A. LUNALIS*, sp. n. (Plate III.)

Head, thorax, and patagia buff; first segment of abdomen brown followed by a pale band, the remainder golden. Fore wing dark brown; a pale brown stripe runs from the body and reaches the costa about midway; it is then continued as a fine line along the costa to the apex; along the inner margin is a whitish stripe with an angulated upward projection towards the middle of the wing; on the disc is a crescent-shaped white mark and this is followed by a white subterminal line with an orange band beyond; fringes pale. Hind wing: the base for about one-third of the wing is white, the remainder orange; on the margin are four black dots, the two exterior having white spots above them; in the middle of the wing are two black lines nearly parallel to hind margin.

Exp. 20 mm.

*Hab.* Dinawa.

56. *A. PURPUREALIS*, sp. n. (Plate III.)

Head, thorax, and abdomen purplish grey; fore legs pale ringed with dark. Fore wing purplish grey with orange markings; a curved irregular band beginning on the inner margin and joining an orange band along the hind margin which is preceded by a silvery band; nearer the base is a dusky orange patch followed by a crescent of purple and then a long triangular mark of orange. Hind wing purplish grey at base, with a broad median band followed by a darker band, and finally by a narrow orange marginal band in the middle of which are seven silver-studded black spots; fringes paler.

Exp. 25 mm.

*Hab.* Dinawa.

57. *A. BIPUNCTALIS*, sp. n. (Plate III.)

Head pale brown, thorax and first segment of abdomen dark brown, followed by a slightly paler band; legs pale ringed with dark brown. Fore wing dark brown; with a white streak fading into buff on the inner margin; a white subterminal line followed by an orange band; fringes yellow. Hind wing: basal third white, remainder orange, with a short white band bordered with dark near the angle and a dark line parallel to the first but nearer

to the base of wing; three black dots on the hind margin, two of which have white dots above them.

Exp. 23 mm.

*Hab.* Dinawa.

58. *PARTHENODES RECTANGULALIS*, sp. n. (Plate IV.)

Head, legs, palpi, and patagia white; thorax black above; antennæ and abdomen dark brown. Fore wing: costa straight, hind margin nearly at right angles for half the width of wing, then slightly oblique to angle of wing; ground-colour white, with black border to hind margin and a parallel transverse narrow band at one-third of wing; from where this meets the inner margin is a narrow oblique red band to base of costa; from the lower end of black line on the hind margin is a double red oblique streak reaching costa and extending to middle of wing, becoming smoky on reaching the inner margin. Hind wing: base and hind margin white, followed by a smoky band, becoming red nearer the body and containing three white specks, slightly angulated. Fringes white.

A very striking species both in form and colour.

Exp. 24-30 mm.

*Hab.* Ekeikei, Dinawa.

59. *TALANGA TOLUMNIALIS* Wlk.

60. *BRADINA IMPRESALIS* Led.

61. *B. MELANOPERAS* Hmps.

62. *B. GLAUCINALIS* Hmps.

63. *ORPHNOPHANES EUCERALIS* Wlk.

64. *COPTOBASIS MESOPSECTRALIS* Hmps.

65. *DRACÆNURA ALBONIGRALIS* Hmps.

66. *D. HOROCHROA* Meyr.

67. *D. TORRIDALIS*, sp. n. (Plate III.)

Head and thorax fuscous; abdomen and posterior half of patagia pale buff, last three segments of abdomen fuscous; tuft buff; legs and underside white. Fore wing fuscous shot with purple, a dark central spot and a transverse dark mark at end of cell; beyond this is a curved thin dark line; fringes paler. Hind wing yellowish, the extreme hind margin darker, shading gradually into the colour of the wing and almost destitute of fringe in the male.

Exp. 33 mm.

*Hab.* Kebea.

68. *D. UNICOLORALIS*, sp. n. (Plate IV.)

Vertex of head pale, palpi and thorax dark grey; posterior end of patagia and abdomen pale; tuft black and a thin black

lateral fringe. Fore wing olive-grey shot with purple, a minute black apical dot and fine black dots on hind margin; fringe pale. Hind wing: outer margin as fore wing; internal area straw-colour.

Exp. 36 mm.

*Hab.* Dinawa, one specimen.

69. *PILETOCERA INCONSPICUALIS*, sp. n. (Plate IV.)

Fore tarsi naked.

Head, legs, antennæ, tarsi, thorax, and abdomen dark brown; tuft whitish orange. Fore wing dark brown with faint purplish tinge; an antemedian, median, and postmedian angulated transverse line darker; a white dot at end of cell and another in the middle of cell, also a faint dot where the postmedian line reaches the costa. Hind wing with two angulated darker lines. Fringes dark with lighter patch at angle of wing.

Exp. 30 mm.

*Hab.* Kebea.

Subfam. PYRAUSTINÆ.

70. *PYCNAEMON JAGUARALIS* Guen.

71. *P. LACTIFERALIS* Wlk.

72. *EUTEPHRIA CRIBRATA* Fabr.

73. *ZINCKENIA FASCIALIS* Cram.

74. *HETEROCNEPHES SCAPULARIS* Led.

75. *REHIMENA PHRYNEALIS* Wlk.

76. *AGROTERA PICTALIS* Warr.

77. *A. FUMOSA* Hmps.

78. *A. EUDOXANTHA* Hmps.

79. *A. FLAVIBASALIS* Hmps.

80. *A. SEMIPICTALIS*, sp. n. (Plate IV.)

Head, thorax, and front of abdomen yellow spotted with orange, last three segments of abdomen purple; tuft orange. Fore wing: basal portion pale yellow flecked with orange, abruptly and obliquely terminated by a patch of rich brown shot with purple occupying the rest of the wing, in the middle of which is a red irregular spot; the costa towards the apex is paler, and there is an obscure darker curved line in the middle of the wing. Hind wing similar to the fore wing, but without the red spot. Fringes conspicuously white with dark interruptions, giving the idea of a scalloped margin.

Exp. 30 mm.

*Hab.* Dinawa.

81. *PAGYDA PARAPHRAGMA* Meyr.

82. *CNAPHALOCROCIS MEDINALIS* Guen.

83. *MARASMIA FUSIFASCIALIS* Hmps.

84. *RHIMPHALEA HERANIALIS* Wlk.

85. *R. SCELATALIS* Led.

86. *R. LINEALIS*, sp. n. (Plate IV.)

Head and thorax golden; palpi, antennæ, and legs brown; patagia darker; abdomen golden, but darker on the margin of each segment; tuft golden. Fore wing whitish with purple gloss and margins edged with gold, with numerous connected streaks and blotches of purplish brown. Hind wing similar, but the chief blotch is at the apex and a secondary blotch at angle. Fringes paler.

Exp. 30 mm.

*Hab.* Dinawa.

87. *SYNGAMIA FLORIDALIS* Zell.

88. *S. AMPLIATALIS* Led.

89. *S. MARMORATA* Lucas.

90. *BocCHORIS TELPHUSALIS* Wlk.

91. *B. ADIPALIS* Led.

92. *B. INVERTALIS* Snell.

93. *B. AUROTINCTALIS* Hmps.

94. *B. EUPIRANORALIS* Wlk.

95. *PILOCROCIS ANIGRUSALIS* Wlk.

96. *P. COPTOBASIS* Hmps.

97. *ULOPEZA CRUCIFERALIS*, sp. n. (Plate IV.)

Head, antennæ, legs, and palpi bright ochreous; abdomen same colour in female, but lighter in male; tuft pale. Fore wing ochreous clouded with purple; three equidistant spots on costa are produced in widening angulated bands until they meet a longitudinal band on inner margin; in the middle of the outer band is a projection reaching the hind margin. Hind wing yellow; fringes same colour.

Exp. 26 mm.

*Hab.* Ekeikei, Mafalu.

98. *NOSOPHORA DISPILALIS* Hmps.

99. *N. FULVALIS* Hmps.

100. *N. SEMITRITALIS* Led.

101. *N. BARBATA* Hmps.

102. *CHALCIDOPTERA EMISSALIS* Wlk.

103. *CAPRINIA FELDERI* Led.

104. *C. CONGLOBATALIS* Wlk.

105. *C. CASTANEALIS*, sp. n. (Plate IV.)

Head, thorax, and abdomen above dark grey, a white band on first segment of abdomen. Fore wing black at base followed by a white band for one-third of wing, this is edged with black and the tip of the wing is also black, between them the space is bright chestnut; on the costa and extending to bottom of cell is a white spot and there is a white dot on the inner margin. Hind wing: basal half white, remainder chestnut; margin broadly darker. Fringes dark.

Exp. 34 mm.

Hab. Ekeikei, Kebea, Mafalu.

106. *C. OCELLALIS*, sp. n. (Plate IV.)

This insect resembles *Rhimphalea trogusalis* Wlk., but differs in the following particulars:—The spot in the cell is developed into a distinct ocellus with white centre, black ring, and yellow space with outer dark line, and it is much more vivid on the under-side; the postmedian line is double with a yellow centre, and there is a distinct parallel subterminal line, the hind margin being yellowish with a dark cloud in the centre.

Sir G. Hampson considers that its right place is in the genus *Caprinia*.

Exp. 27 mm.

Hab. Ekeikei.

107. *FILODES XANTHALIS* Hmps.

108. *TYSPANODES RADIATA*, sp. n. (Plate III.)

Head, thorax, and tuft orange; collar black; legs grey. Fore wing grey with whitish hyaline patches and streaks; a dark spot at base of costa followed by pale orange, then a transverse narrow black band, after this a triangular white patch from costa to inner margin, the nervures 1 and 2 showing on this; beyond is a large irregular white patch, the apex being broadly dark grey; fringe greyish yellow. Hind wing dark with the nervures whitish and an oval white patch beyond the middle; fringe greyer than in the fore wing.

Exp. 44 mm.

Hab. Kebea.

109. *NEVRINA PROCOPIA* Cram.

110. *PHRYGANODES MACULICOSTALIS* Hmps.

111. *P. GLYPHODALIS* Wlk.

112. *P. OBSCURATA* Moore.

113. *P. BASALTICALIS* Led.

114. *P. ODONTOSTICTA* Hmps.

115. *P. MARGARITA* Butl.

116. *DICHOCROCIS XANTHOCYMA* Hmps.

117. *D. EVAXALIS* Wlk.

118. *D. PUNCTIFERALIS* Guen.

119. *D. NIGRILINEALIS* Wlk.

120. *D. PARDALIS*, sp. n. (Plate IV.)

Head and palpi orange; legs paler; tarsi with dark rings; antennæ dark; thorax ochreous, spotted with dark brown; abdomen ochreous with darker cloud on back; tuft dark. Fore wing pale ochreous, with narrow dark basal band and two narrow equidistant bands crossing from costa to inner margin where they are wider or branched; a subterminal dark patch which only extends across half the wing. Hind wing ochreous slightly shot with purple, a dark subterminal line and a narrow dark transverse line across half the wing. Fringes golden. All the markings variable.

Exp. 30-40 mm.

*Hab.* Mufalu.

121. *D. BIMACULALIS*, sp. n. (Plate IV.)

Head, palpi, antennæ, thorax, and abdomen above wainscot-colour; legs and underside pale and shining; patagia extending a little beyond thorax. Fore wing greenish buff; three yellow patches on costa passing into orange and bordered with brown, extending a little below middle of wing, the outer patch is made up of two elliptical yellow dots. Hind wing smoky, tinged with golden and spotted with darker underneath; fringes paler.

Exp. 31 mm.

*Hab.* Kebea, Dinawa.

122. *NACOLEIA CHARESALIS* Wlk.

123. *GONIORHYNCHUS GRATALIS* Led.

124. *DEBA SURRECTALIS* Wlk.

125. *D. ALTHEALIS* Wlk.

126. *BOTYODES ASIALIS* Guen.

127. *B. FLAVIBASALIS* Moore.

128. *SYLEPTA MULTILINEALIS* Guen.

129. *S. CHROMALIS* Wlk.

130. *S. CHALYBIFASCIA* Hmps.

131. *S. DISSIPITALIS* Led.

132. *S. AURANTIACALIS* Fisch.

133. *S. SOLILUCIS* Hmps.

134. *S. PERNITESCENS* Swinh.



135. *SYLEPTA OCHRIFUSALIS* Hmps. n.
136. *S. ACRIDENTALIS* Hmps. n.
137. *AGATHODES OSTENSALIS* Geyer.
138. *GLYPHODES PFEIFFERÆ* Led.
139. *G. LATICOSTALIS* Guen.
140. *G. HILARALIS* Wlk.
141. *G. SURALIS* Led.
142. *G. AMPHITRITALIS* Guen.
143. *G. UNIONALIS* Hübn.
144. *G. CELSALIS* Wlk.
145. *G. STOLALIS* Guen.
146. *G. ITYSALIS* Wlk.
147. *G. ZELIMALIS* Wlk.
148. *G. EURYTUSALIS* Wlk.
149. *G. CÆSALIS* Wlk.
150. *G. CANTHUSALIS* Wlk.
151. *G. BICOLOR* Swains.
152. *G. ACTORIONALIS* Wlk.
153. *G. INDICA* Saund.
154. *G. FLAVIZONALIS* Hmps. n.
155. *G. UMBRIA* Hmps. n.
156. *G. AGATHALIS* Wlk.
157. *G. MARGARITARIA* Grun.
158. *G. SUBACUSALIS* Wlk.
159. *G. SECTINOTALIS* Hmps. n.
160. *G. DELICIOSA* Butl.
161. *G. OPHICERALIS* Wlk.
162. *G. GLAUCULALIS* Guen.
163. *G. EXAULA* Meyr.
164. *G. TRICOLORALIS* Pag.
165. *G. ÆGEALIS* Swinh.
166. *G. MARINATA* Fabr.
167. *G. DOLESCHALI* Led.
168. *G. HYPOMELAS* Hmps. n.
169. *G. EURYGANIA* Druce.

170. *G. QUADRISTIGMALIS*, sp. n. (Plate IV.)

Male with antennæ slightly pectinated; female quite simple.

Head, legs, antennæ, and palpi bright ochreous; patagia in male twice the length of the thorax; thorax and body ochreous; tuft black. Fore wing: ground-colour ochreous with slight purple iridescence; three equidistant dark purple bands on the costa are produced until they meet an irregular band of the same colour from inner margin along the middle of the wing; a faintly darker subterminal line. Hind wing divided sharply into three triangular divisions; those on the costa and inner margin ochreous, but the middle one is iridescent and has a darker transverse bar; on the hind margin are three double black dots followed by three single dots all surrounded by metallic scales.

Exp. 32 mm.

Hab. Ekeikei.

171. *G. PUDICALIS*, sp. n. (Plate IV.)

Head, thorax, antennæ, and abdomen pale ochreous above, shining white below; palpi with third joint brown; legs white; sides of tuft black. Fore wing hyaline with golden and purple reflections; a postmedian angulated transverse line and a faint mark at end of cell. Hind wing similar to fore wing. Fringes pale.

Exp. 30 mm.

Hab. Kebea.

172. *G. PAUCILINEALIS*, sp. n. (Plate IV.)

Head, thorax, and abdomen pale with darker longitudinal lines; underside, legs, and palpi paler; antennæ brown. Fore wing crossed by narrow dark bands not parallel and each having a central yellowish line; the third and fourth touch at costa, beyond them is an irregular subterminal line broader at the apex; the spaces between the bands are shining white. Hind wing with only two bands, forming a triangle with apex at angle of wing; a darker mark on hind margin.

Exp. 24 mm.

Hab. Dinawa.

173. *G. MULTILINEALIS*, sp. n. (Plate IV.)

Very much like the above, but the bands are so much wider that the space left for the white ground-colour is so much reduced as to suggest a dark wing crossed by numerous white lines which are not parallel. The details can be better shown in a figure than described.

Exp. 31 mm.

Hab. Dinawa, Ekeikei.

174. *G. PERSPICUALIS*, sp. n. (Plate IV.)

Head, top of thorax, and abdomen chestnut; patagia, sides of abdomen, and underside pure white; tuft black. Fore wing

golden chestnut, with hyaline white blotches surrounded by darker lines; a basal triangular spot; an antemedian oval spot; a postmedian ovate spot, three small dots between these two; an apical spot with a line of dots below reaching to inner margin; two half spots along inner margin; fringes brown, white at angle. Hind wing hyaline with marginal dark band intersected by row of chestnut spots; fringes brown, spotted with white.

Exp. 32 mm.

*Hab.* Dinawa.

175. *G. EXQUISITALIS*, sp. n. (Plate IV.)

Head, palpi, and thorax brown; abdomen in the male grey, in the female yellow; tuft black. Fore wing chestnut faintly shot with blue and purple; the spots hyaline and yellowish in the male but white in the female; a streak from costa at base sloping to middle of wing in hind margin; an antemedian triangular costal spot with long tapering end; a broad postmedian costal spot extending almost to hind margin, with a darker outside margin and slight projection into the spot from outside; two very faint purple, parallel, subterminal lines; fringes golden. Hind wing pale straw-colour; in the middle of the hind margin are a few black dots set in bright golden scales; fringes golden. In the male the hind wing is dark grey and the fore wing darker.

Exp. 32 mm.

*Hab.* Kebea.

176. *G. BRUNNEOMARGINALIS*, sp. n. (Plate IV.)

Head, thorax, and palpi green; antennæ dark; abdomen green, but silvery beneath. Fore wing apple-green with yellowish costa and margins; one black dot at end of cell and one in the middle. Hind wing green, one large black dot at end of cell, margins having a scorched appearance fading into white nearer the body. Fringes smoky, but inclined to chestnut at angle.

Exp. 32 mm.

*Hab.* Kebea.

177. *G. LACERITALIS*, sp. n. (Plate IV.)

Head, thorax, and palpi apple-green; antennæ and last joint of palpi brown; legs white, but tibiæ of fore legs with brown hairs; abdomen green above, white at sides and bluish white beneath; tuft black with white centre. Fore wing apple-green; hind margin distinctly and irregularly scalloped, edged with brown as if scorched; one black dot in middle and one at end of cell. Hind wing apple-green, scalloped and scorched like fore wing; one black dot at end of cell; inner margin white and hyaline with fringe of same; other fringes brown.

Exp. 44 mm.

*Hab.* Ekeikei, Kebea, Dinawa, Mafalu.

178. *Pygospila bivitalis* Wlk.179. *P. marginalis*, sp. n. (Plate IV.)

Head purplish grey; palpi, thorax, and abdomen dark grey above, shining white below; legs white; patagia grey shot with purple. Fore wing grey shot with purple; a white patch on vein below costa at two-thirds length of wing from base, 2 mm. wide, ending in three white dots towards inner margin; a second white patch between base and first patch; between this and angle of wing two smaller patches and one still smaller on inner margin; fringes grey. Hind wing dark grey shot with purple, discal portion semitransparent with central spot and serrated dark band; fringes white.

Exp. 45 mm.

*Hab.* Mafalu.

180. *P. imperialis*, sp. n. (Plate IV.)

Head, thorax, and abdomen grey, striped with white; palpi black, first and second joints white; underside white. Fore wing dark grey shot with rich purple; a round white spot near base surrounded by four white dots; two median, two postmedian, and two smaller anteterminal white blotches. Hind wing: ground-colour as fore wing, one long triangular basal blotch, five other blotches on disc. Fringes dark, flecked with white at angle of wing.

Exp. 36 mm.

*Hab.* Ekeikei, Kebea.

181. *Heortia vitesoides* Moore.182. *H. dominalis* Led.183. *Polythlipta macralis* Moore.184. *P. divaricata* Moore.185. *Lepyrodes perspicata* Fabr.186. *Metreea nebulalis* Wlk.187. *Leucinodes apicalis* Hampsh.188. *Sameodes tristalis*, sp. n. (Plate IV.)

Head, legs, antennae, and palpi very dark grey; thorax slightly paler; abdomen with first three segments paler. Fore wing dark grey with a V-shaped white transverse mark having its apex on the inner margin; near the outer margin of this mark is a thin angulated dark line. Hind wing dark with irregular transverse paler band; fringes dark, spotted with white.

Exp. 24 mm.

*Hab.* Dinawa.

189. *Meroctena staintoni* Led.190. *Thliptoceras octoguttale* Feld.

191. *ARCHERNIS CALLIXANTHA* Meyr.
192. *A. EUCOSMA* Turner.
193. *A. IGNEALIS* Wlk.
194. *ISOCENTRIS MINIOSALIS* Guen.
195. *I. MINIALIS* Warr.
196. *MARUCA TESTULALIS* Geyr.
197. *PACHYNOA THOOSALIS* Wlk.
198. *P. SPILOSOMOIDES* Moore.
199. *PACHYZANCLA DESMIOIDES* Hmps.
200. *P. PALLIDALIS* Hmps.
201. *PROCEDEMA INSCISALIS* Wlk.
202. *BCEOTARCHA HYALINALIS* Hmps.
203. *B. LIMBATA* Butl.
204. *CALAMACHROUS TRANQUILALIS* Led.
205. *C. ALBIPUNCTALIS*, sp. n. (Plate IV.)

Palpi dark purplish brown; head orange; thorax and patagia purplish brown; abdomen above fuscous; thorax and abdomen below, legs and underside of palpi white. Fore wing dark purplish brown, with a subtriangular patch from the middle of the costa to middle of the wing orange, paler inside and with a minute orange dot in the middle; hind margin broadly orange with a row of subterminal dots. Hind wing white on costa, the middle of the wing occupied by a triangular purplish patch, the apex reaching the base of the wing; between this and the inner margin is white; the hind margin broadly orange and fringe orange; in the centre of the patch are two minute white dots edged with dark.

Exp. 44 mm.

*Hab.* Dinawa.

206. *PIONEA ABLACTALIS* Wlk.
207. *P. NYPSIUSALIS* Wlk.
208. *P. ALBIFIMBRIALIS* Wlk.
209. *P. BRACTEALIS*, sp. n. (Plate IV.)

Head, thorax, abdomen, and legs pale ochreous, inclining to reddish above but shining white below, very noticeable on tibia; palpi with third joint chestnut. Fore wing golden yellow; costa margined with reddish; five equidistant, thin, angulated, somewhat interrupted transverse lines. Hind wing the same, with three faint lines. Fringes pale.

Exp. 30 mm.

*Hab.* Dinawa, Ekeikei.

210. *PYRAUSTA CELATALIS* Wlk.211. *P. ERIOPISALIS* Wlk.212. *P. CEADESALIS* Wlk.213. *P. TRITICALIS*, sp. n. (Plate III.)

Head and thorax orange; patagia darker; abdomen paler with chestnut markings along the crest; palpi and antennæ dark brown; underside and legs whitish; tarsi ringed with darker. Fore wing orange with dark margin on the costa, dark nervures, and the cell margined with darker; an oblique line, dark brown, passes through the cell and reaches the hind margin; a second oblique dark line reaches from the middle of the hind margin to near the apex. Hind wing straw-colour, margined with darker. Fringes smoky with white edges.

Exp. 26 mm.

*Hab.* Dinawa.214. *POLYGRAMMODES GROSSALIS* Guen.215. *P. PURPURALIS* Wlk.216. *OMPHISA INGENS* Hampson.

In concluding this list I desire to tender my most hearty thanks to all those who have assisted in determining the species and especially to Sir G. Hampson, Col. Swinhoe, and Dr. Dixey, who kindly allowed me to see the Walker types in the Hope Museum at Oxford.

## EXPLANATION OF THE PLATES.

PLATE III.	PLATE IV.
No.	No.
6. <i>Phycita dinawa</i> , p. 69.	5. <i>Monodonta passalis</i> , p. 69.
7. <i>Etiella fuscalis</i> , p. 69.	58. <i>Parthenodes rectangularis</i> , p. 77.
14. <i>Macalla unipunctalis</i> , p. 70.	68. <i>Dracænura unicoloralis</i> , p. 77.
15. " <i>caradriniformis</i> , p. 70.	69. <i>Pileocera inconspicualis</i> , p. 78.
16. " <i>pomalis</i> , p. 70.	80. <i>Agrotera semipictalis</i> , p. 78.
17. " <i>curturalis</i> , p. 70.	86. <i>Rhimphalea linealis</i> , p. 79.
18. " <i>apicalis</i> , p. 71.	97. <i>Ulopeza cruciferalis</i> , p. 79.
20. " <i>perdentalis</i> , p. 71.	105. <i>Caprinia castanealis</i> , p. 80.
21. " <i>porphyrealis</i> , p. 71.	106. " <i>ocellalis</i> , p. 80.
23. <i>Polylophota truncalis</i> , p. 72.	120. <i>Dichocrocis pardalis</i> , p. 81.
24. <i>Locastra castanealis</i> , p. 72.	121. " <i>bimaculalis</i> , p. 81.
29. <i>Stericta flammealis</i> , p. 72.	170. <i>Glyphotes quadristigmatis</i> , p. 83.
30. " <i>cornucalis</i> , p. 73.	171. " <i>pudicalis</i> , p. 83.
31. " <i>subcitrinalis</i> , p. 73.	172. " <i>paucilinealis</i> , p. 83.
33. <i>Orthaga polychroalis</i> , p. 73.	173. " <i>multilinealis</i> , p. 83.
34. " <i>chionalis</i> , p. 73.	174. " <i>perapicalis</i> , p. 83.
35. " <i>fuscifascialis</i> , p. 74.	175. " <i>exquisitalis</i> , p. 84.
36. " <i>columbalis</i> , p. 74.	176. " <i>brunneomarginalis</i> , p. 84.
42. <i>Tipuliforma triangularis</i> , p. 75.	177. " <i>laceritalis</i> , p. 84.
45. <i>Vitessa griseata</i> , p. 75.	179. <i>Pygospila marginalis</i> , p. 85.
55. <i>Aulacodes lunalis</i> , p. 76.	180. " <i>imperialis</i> , p. 85.
56. " <i>purpurealis</i> , p. 76.	188. <i>Sameodes tristalis</i> , p. 85.
57. " <i>bipunctalis</i> , p. 76.	205. <i>Calamachrous albipunctalis</i> , p. 86.
67. <i>Dracænura torridalis</i> , p. 77.	209. <i>Pionea bractealis</i> , p. 86.
108. <i>Tyspanodes radiata</i> , p. 80.	
213. <i>Pyrausta triticalis</i> , p. 87.	

5. On some new and insufficiently known Species of Marmoset Monkeys from the Amazonian Region. By Prof. Dr. EMIL A. GOELDI, C.M.Z.S., Director of the Pará Museum.

[Received November 23, 1906.]

(Text-figures 20-23.)

On the occasion of the Sixth International Zoological Congress, held at Berne (Switzerland) in August 1904, I presented a paper, "Nova zoologica from the Amazonian Region, dealing especially with new Vertebrates," in which I discussed at some length new and little-known representatives of the family of Callitrichidae (Hapalidae, auctorum\*) from the Upper Amazon, especially from the Rio Purús, as follows:—(1) A species of *Midas* whose close relationship with *Midas rufiventer* Gray I recognised at first sight, and to which later on, after comparing it with the type-specimen of this latter in the British Museum in London (at the time of my visit to the International Ornithological Congress in July 1905), I decided to give the name of *Midas griseoverter*. (2) A second species of *Midas*, evidently related to *M. labiatus* Geoffr. (1812), *M. illigeri* (id. 1845), and *M. weddellii* (id. 1849), and having as its most characteristic distinguishing feature an enormously long white moustache, which afterwards, on the same occasion, I decided to name *Midas imperator*. (3) *Midas pileatus*, described by Geoffroy in 1848 from the original specimen from the Rio Javary, kept in the Paris Museum, and until recently not represented in any other Museum, so far as could be judged from current zoological literature. I was then able to show a splendid pair of this very rare species. (4) *Midas fuscicollis*, described so long ago as 1823 by Spix, but only from immature specimens, the habitat of the adult animal of both sexes having escaped notice, as it appears, in a surprising manner until 1904. (5) *Midas mystax* Spix, originally described from the Rio Solimões, represented in my exhibited collection by a very dark specimen from the Rio Juruá.

One of the essential conditions for arriving at certainty in my conclusions, as above suggested, was the careful examination of certain individuals kept as type-specimens in the British Museum. The purpose of the present article is principally to record the result of my investigation in this respect, which proves to be most interesting and instructive. To say it at once: the most remarkable and unexpected discovery was the fact, that of the two specimens of *Midas rufiventer*, type and quasi co-type, on the shelves in the British Museum, the latter does not coincide with the former, but, on the contrary, should constitute the type-specimen of a new, overlooked, and undescribed species of the genus *Midas*.

\* See Thomas, Ann. Mag. N. H. (7) vol. xii. (1903).

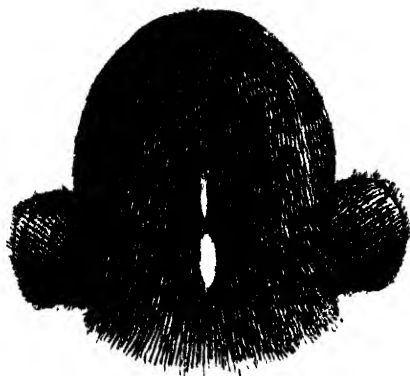
**MIDAS THOMASI, sp. n. (1905).**

[Labelled in the British Museum: "*Midas rufirenter*, ♂, 'The red-bellied Tamarin,' Upper Amazonia. W. Bates. Exp. 1857 *a*. Tunantins, north side of Amazons."]

**DORSAL ASPECT.**—Anterior half of a dark, deep blackish-brown colour (somewhat like the half-grown *M. fuscicollis*), extending from behind the ears as far as the middle of the back. Hinder half of the same brown, the tips of the hairs being however mottled with a lighter greyish-brown, but in a much less pronounced degree than in the typical *M. rufirenter*.

**Head** (text-fig. 20) black, with an insignificant median small light spot beginning just between the ears, behind the vertex; a still less noticeable lightish dash, consisting only of a few greyish hairs, almost forming an anterior continuation, is perceptible in the same median line just in front of the former. Details of the region of mouth and nose as in the type of *M. rufirenter*.

Text-fig. 20.



Back view of head of *Midas thomasi*.

**Arms** dark blackish-brown, passing into a true black towards the hands, not being, however, a brilliant black as in the *M. rufirenter* type.

**Legs.** Exterior side of thighs of the same colour as the posterior half of the back, turning to black toward the feet.

**Tail** black.

**VENTRAL ASPECT.**—Anteriorly a cross-zone of light reddish-yellow (viz., inside of arms and a band across the breast as wide as the insertions of the arms). Rest from there backwards reddish rust-yellow (lighter than in the new species *M. griseovortex* G., and much lighter than in *M. rufirenter* type).

The light under side is abruptly separated in the region of the neck and breast from the black of the neck and head. (This light abdominal colour cannot be attributed to fading of an old



Museum specimen, perhaps unduly exposed to light on the shelves, because in that case such change would certainly be even more noticeable in the colouring of the back, which, although more exposed, still holds however its colour fast; consequently the impression is produced of a decidedly distinguishing character of specific rank.) The light abdominal colour extends to the under side of the insertion of the tail, as in *M. rufiventer* type and in the other new species, *M. griseovertex*.

On separating the fur the deeper portion is of the dark colouring, which is lighter in the anterior than in the posterior half of the body, and thus corresponding perfectly with the scale of colouring of the external aspect of the fur.

The only existing specimen (stuffed) dates, as noted above in the copy of the label, from Tunantins, Upper Amazon, where it had been collected in 1857 by Henry W. Bates.

Let us now proceed to the description of the type-specimen of the true *Midas rufiventer* Gray, in the British Museum, in order to relieve once for all the deplorably embarrassing situation caused by the very defective descriptions given up to the present time.

#### MIDAS RUFIVENTER.

[“Brit. Mus. Reg. 43.10.12.6. Type (skin). Locality: South America. Purchased of Argent. ♂ (skull).”]

I must state at the outset, that I was informed by Mr. Oldfield Thomas that the specimen had been obtained from a dealer, a fact which accounts for the vagueness of the locality.

In general the results of my examination coincide with the description given by Gray in his ‘Catalogue of Monkeys, etc.’ 1870, p. 66, of this original specimen, only that it is too brief.

**DORSAL ASPECT.** Predominating colour of the back a dark blackish-brown. Hairs light greyish for the apical  $\frac{1}{4}$  of their length. Anterior part of back less greyish, posterior part of back more so. The fur down to the roots dark brown (not light greyish-brown).

**Head** (text-fig. 21). General colouring of the head a deep black, not blackish-brown. Mouth bordered with sparse whitish hairs. Central zone between and beneath the nostrils sparsely covered with lightish grey hairs (not brilliantly white).

A spear-shaped *dark rust-red median stripe* extending from the vertex between the ears downward to the insertion of the nose, the rust-red being of the same intensity as the colour of the whole abdominal side. From the vertex backward, in form of a double ploughshare, over the occiput down to the neck spreads out *a patch of a greyish-brown colour*, which combined with the lance-shaped frontal marking forms a comparatively broad triangle with a tendency to lateral posterior development.

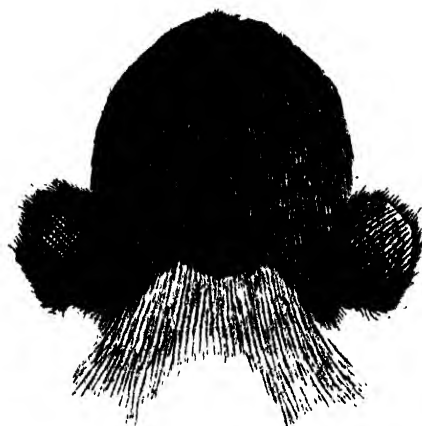
**Arms.** Outer side deep dark brown (like the head), slightly lighter on the upper arm.

*Legs.* Outer side of the same colour as the posterior part of the back.

**VENTRAL ASPECT.**—General colour a deep dark chestnut reddish-brown, considerably darker than in the Purús species, *M. griseo-vertex*.

*Tail* very long, dark blackish-brown, turning blacker toward the end.

Text-fig. 21.



Back view of head of *Midas rufiventer*.

So far as I know the only figure as yet published of a specimen of Marmoset Monkey, closely resembling this type-specimen of *Midas rufiventer* in the British Museum, is that in the supplementary plate 36 of the work of Reichenbach, under the name of "*Midas erythrogaster* Natterer, Mus. Vindob.," made, as stated on p. 14, from an original sketch by a Mr. T. E. Zimmermann of a skin collected by Natterer and preserved in the Vienna Museum. With no little surprise I discover, however, that Pelzeln, the excellent monographer of the Brazilian mammals collected by Natterer, enumerates this very specimen, and also the figure in Reichenbach, as synonyms under the head of *Midas labiatus* Geoffroy, a procedure which seems to me more than doubtful, not to say flatly erroneous. In this figure, though worthy of criticism in some respects (the most salient defect being the substitution of the delicate mottling by rough daubs of black on a greyish ground), one essential feature nevertheless stands out clearly, namely the rust-coloured frontal spot, coinciding perfectly with the abdominal colour.

I have never been able to consult either the full description, or any figure, or any other useful information concerning the *M. elegantulus* Slack, Proc. Academy of Natural Sciences of Philadelphia, 1861, p. 463, always quoted as a synonym of *M. rufiventer* Gray.

Having now finished these explorations of the treasures stored up in the British Museum as an essential preliminary and solid basis for the discussion of the respective questions that arise, I will proceed to the detailed description of the two new species of Marmoset Monkeys of the Purús Region, mentioned at the beginning of the present article.

*MIDAS GRISEOVERTEX*, sp. n.

In general aspect closely similar to *M. rufirenter* Gray and *M. thomasi* Goeldi, in the sharp contrast between the bright rusty-coloured abdominal side and the dark colouring of the dorsal aspect, but distinguishable at a glance by the greyish-white, good-sized rounded frontal patch.

Among the collections made in the Purús and Acre Regions by our Museum Expeditions (1903-1904) there are seven individuals of this most interesting and well characterised species of Marmoset Monkey (skins, skulls of all and trunks of some), 4 being males and 3 females. One mounted pair (♂ ♀) remained in the Museum at Berne, labelled as above; three mounted individuals (♂, ♀, and a half-grown young one) are kept in the Para Museum; and the remaining pair of skins (♂ ♀) are intended for the British Museum.

**DORSAL ASPECT.**—General colour deep blackish-brown, excepting head, hands, feet, and tail, which are positively black. This colour remains pure from the nape of the neck backward for one-third of the length of the back. The hinder two-thirds of the back shows a mottling due to the light greyish tips of the hairs, which terminal points measure about  $\frac{1}{4}$  of the entire length of the hair and are slightly longer toward the hips; the intensity of the mottling increasing gradually backwards, being most pronounced in the sacral region, presenting even a whitish appearance, when seen from certain oblique directions.

On separating the fur in the region of the shoulders, the impression of colour is in general the same as the exterior, that is deep blackish-brown, excepting that the lower third of the hairs towards the roots forms a slightly lighter zone, especially laterally to the median line. Making the same examination in the region of the hips, the light zone is scarcely apparent, the fur being of the general colour almost down to the roots.

**Head.** General colour sooty-black. A narrow zone of whitish hairs bordering the whole extent of the mouth. In the region of the upper lip the white zone rises in a very conspicuous triangular zone, with its broad base resting on the circular white band of the mouth. One very noteworthy feature of this triangular zone is that the lateral oblique lines cross exactly the middle of the nostrils, so that the exterior half of each falls in the blackish region, the interior half in the whitish triangle.

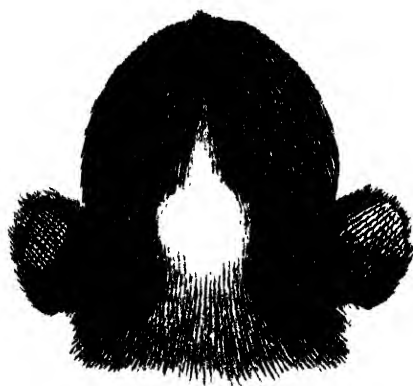
At the vertex, from a line connecting the anterior borders of the ears, commences a whitish patch (text-fig. 22), occupying

about  $\frac{1}{3}$  to  $\frac{2}{3}$  of the width between the ears and widening slightly backwards, but in no specimen acquiring the double ploughshare-shape of the rust-coloured patch of the *Midas rufiventer* type. In young individuals this patch is rather more greyish, while in more aged specimens it becomes nearly white. In length it extends as far as the posterior border of the occipital region.

*Arms.* Outer side from shoulder to elbow of the same sooty blackish-brown as the whole shoulder region; fore-arms and hands decidedly black.

*Legs.* Outer side of the same intensely mottled colour as the entire hip-region as far as to the foot; the foot itself of the same black as the hand.

Text-fig. 22.



Back view of head of *Midas griseovertex*.

**VENTRAL ASPECT.**— General colour light reddish rusty, decidedly lighter than in *Midas rufiventer*. It embraces the whole area from the middle of the throat, breast, and belly, inner side of arms and legs, and a short distance beyond the insertion of the tail on its under side (some 5 cm.). On the flanks the dorsal and ventral colours are very abruptly separated, it being noteworthy that the rusty-coloured hairs of the abdominal side are only about half as long as the adjacent dark-coloured hairs of the dorsal part.

\* *Tail* long, exceeding the length of the body by that of the head. Colour the same black as of the fore-arms and hands, but here and there with rows of hairs with light brownish tips, which may be interpreted probably as the vestiges of an annular arrangement.

#### MIDAS IMPERATOR, sp. n.

In general aspect, especially in colour, somewhat similar to *M. labiatus* Geoffr., *M. illigeri*, and *M. weddellii*, but easily distinguished by the immense white moustache, which becomes

phenomenal especially in the adult male. (Text-fig. 23 represents the head of an old male individual.)

Our Purús collections embrace five skins (and skulls) (3 ♂ ♂, 2 ♀ ♀), two from the Rio Acre and three from the upper Rio Purús. A family of three individuals (♂ ♀ adults, and a young one) are already mounted in the Pará Museum; the two remaining (♂, ♀) skins, of half-grown specimens, are destined to be sent to the Museums of Berne and London respectively.

This species is distinguished by a more or less pronounced reddish greyish-brown general colour of the dorsal side, light rust-coloured abdominal side, dark feet, hands, and head, excepting the white circumbuccal zone and the skull-cap, which tend to become grey with age.

Text-fig. 23.



Head of *Milas imperator*.

**DORSAL ASPECT.**—The reddish-rust colour is more conspicuous in the above mentioned old male, and is already noticeable in the two young males (one stuffed in the Pará Museum and one skin). General colour as above stated; it may be noted, however, that the greyish tinge, in the same way, is more pronounced in the female.

On separating the fur nearly every one of the five specimens presents a slightly different appearance. In the two adult stuffed specimens in the Pará Museum the lower half is uniformly dark; the outer half shows alternately a light zone, then a dark one, followed by a light one and a dark one, the terminal zone being again lighter, making five zones of equal breadth in the outer half and giving the general impression of two equal pairs of light and dark zones.

Examining in the same manner the two skins of half-grown individuals (♀, ♂), we see immediately, that while the lower half is dark as above, the outer half shows alternately a light zone, then a dark one, and finally the terminal lighter one, giving as a total result the impression of only one complete pair of light and dark zones. The female skin presents nevertheless a peculiarity in the circumstance that near the roots of the hairs there is an unmistakable trace of a basal light zone—a peculiarity of this one individual among all the five known.

Proceeding now to the examination of the same details in the quite young stuffed specimen of the mounted family in the Pará Museum, the general impression is of only one well-marked pair of dark and light zones, from within outwards, while on closer inspection the second outer pair noticed in the half-grown specimens is unquestionably recognisable.

Recapitulating these facts, the general conclusion is that the number of light and dark zones tends to increase with age. We have here one more useful hint, that in the discrimination of species prudence is required in judging the value to be attributed to such variations in colour, which in the present case can be fairly proved to be due to differences of age and sex.

*Head.* All parts of the full front view of the face and direct lateral view are sooty-black in the adult female, the quite young individual (♂) and the two skins (♂ ♀), while the old male shows the face somewhat mixed up with greyish-brown hairs. The circumbuccal zone, however, is again an exception from this general colour, being saliently pure white. This zone is relatively broader than in any of the preceding species, including the entire nostrils in the old male, while in the other four specimens the border-line of the white colour curves below the nostrils, arising again on the ridge of the nose at about one-third of its length. The same white colour characterises the phenomenal moustache, which already in infant specimens is of a greater length than in any other of the moustached species known to me. The old male (text-fig. 23), however, beats the world's record, the longest hairs attaining a length of no less than 57 to 60 mm.!

My collectors inform me that the moustache is worn in life not straight, but with the modern upward twist. The two oldest specimens show the strange strong development of the white hairs of the circumbuccal zone extending even over the whole area of the lower jaw, not including the chin and inferior side of the jaw. As a result, the old males appear bearded as well as moustached.

In the three younger individuals the crown of the head is brownish-black, with a tendency towards forming the already familiar favourite lighter-coloured patch of a pale brownish shade. In the adult female the patch is diamond-shaped, almost dirty greyish-white, and therefore very conspicuous. In the old male a pronounced greyish cast spreads all over the top of the head, without forming any distinct patch.

*Arms.* Outer side of upper arm the same colour as the back,

but a little lighter in all specimens. Fore-arms and hands gradually darker towards the extremity. This is especially the case in the three young specimens and the old female, while the male shows on the outer side of the fore-arm and hands the same dark greyish cast as noted above in the description of his face.

*Legs.* Outer side of thigh the same colour as the back, but as a rule a little lighter, especially in the old female. The outer side of the foot is of the same dark colour as the hand.

*VENTRAL ASPECT.*—The colour forms a marked contrast with that of the dorsal aspect, by having a pronounced tendency towards a rusty red, especially in the younger specimens. This rusty-red shade covers the whole under side, from the throat backward including the inner side of the arms and legs and no small extent of under side of tail. The same colour tends to form regions or patches of a deeper shade, one between the arms, covering the chest, and another between the legs, covering the abdomen and surrounding the anus. The chest-patch, especially in the old female, looks as if soiled by dried blood.

*Tail.* The tail is long, nearly half as long again as the body (the average length of four specimens measured being as 11 : 8). In the younger specimens the dorsal side nearly from the insertion to the end is of the same dark colour as the feet, while the lower side shows a gradually narrowing line of the above mentioned deep rusty red fading toward the extremity. In the adult specimens the colour of the tail tends to become uniform in its whole circumference. In the old female the upper side is darker than the lower at least for two-thirds of its length, the terminal third being of a dark grey, due to the black roots and the light tips of the hairs. The under side for about half its length has the general light rusty-red colour of the ventral aspect, the terminal half being alike on the dorsal and ventral side, a dark grey.

Most aberrant is the colouring of the tail in the old male. From the very insertion the bright rusty-red colour predominates in its whole circumference throughout its entire length with the exception of a dark terminal tuft. The rusty red is most noticeable to a certain extent (one-eighth) from the insertion backward. Approaching the end the colour is more mixed with dark, owing to the greater extent of black at the roots of the individual hairs. A darker isolated patch exists also on the second eighth.

#### MIDAS FUSCICOLLIS Spix.

This species, it is true, was long ago described, having been introduced into science in 1823 by the Bavarian explorer J. von Spix from individuals obtained on the Rio Javary, but it is evident from our much richer material (eight specimens, 6 ♂ ♂ and 2 ♀ ♀), collected on the Rio Purús, that the pelage of the full-grown animal has never been properly described and figured. Referring to a comparison of the two figures 3 (adult coat) and 3a (juvenile coat) of my original coloured Marmoset-

Monkey plate, presented to the Zoological Congress at Berne and now being reproduced for a separate publication, it is especially noticeable that the adult coat is distinguished by the deep blackish-brown colour of the anterior part of the body.

Briefly described, the colour of a typical adult male is as follows:—

Dorsal aspect of anterior part of body, as far back as behind the shoulders, of a uniform sooty brownish-black. On separating the fur, two-thirds of the length of the hairs is lighter, greyish or dirty white near the roots, pale greyish-brown outwards, the outer third shading into the above-mentioned brownish-black, without presenting any tendency to zonal arrangement. The posterior part of the body presents a mottled appearance, due to the intervention of yellowish-reddish zones. On separating the fur in this region, two-thirds of the length of the hair is quite uniform dark; the last third is about equally divided between the light zone and a black terminal one.

Singularly deep rusty-red are the rump and thighs. This is due to the absence of the dark terminal zone of the hairs in this region, each hair being black at its base, and the terminal third entirely rusty. Tail, arms, and feet black.

Dorsal and ventral aspects are noticeably divided by a lateral rusty-red stripe of shorter hairs on each side, running from the arm-pit to the flank. The real median ventral stripe, wider than the just-mentioned lateral one, again assumes the dark brown colouring of the anterior part of the body.

In the face the most salient features are the white eyebrows, meeting in the median line at the base of the nose, forming a very striking double crescent. Circumbuccal zone whitish, more extensive than in all the preceding species, but not so sharply outlined.

#### MIDAS PILEATUS ls. Geoffroy et Deville.

This species was figured in 1848 by Geoffroy in the 'Archives du Muséum,' vol. v. pl. 31, and described under the name of "Tamarin à calotte rousse," p. 569. Up to the time of my paper read at Berne, at the International Zoological Congress, it seemed to me, judging from the literature within my reach, that it was represented only by the single original specimen, coming from the Rio Javary, and preserved in the Paris Museum. (I saw it there some days before, without a label, stowed away on a side-shelf.)

At that time we had obtained from the upper River Purús two other specimens, a pair. This splendid species has its chief distinguishing marks in the cinnamon-coloured scalp-patch, the brownish-black general colour, and the sharply outlined white circumbuccal zone, including the nostrils, which are completely surrounded by a narrow white band.

Being in London for the Meeting of the Fifth International Ornithological Congress in July 1905, Mr. Oldfield Thomas, of the



department of mammals at the British Museum, to my no small surprise showed me a small series of skins from different points in the Upper Amazon region, one having been furnished by Dr. von Ihering, from the River Juruá expedition.

After my return to Pará I saw by the 'Revista do Museu Paulista,' vol. vi. (1904), p. 416, which had been sent in my absence, that Dr. von Ihering refers to three individuals in the collections made by Mr. Garbe at the time of the above mentioned Juruá trip. He, however, classifies it as a new subspecies—*M. pileatus juruanus*—which according to his statement is distinguished by the dark colour of the hair of the back, which in the description of the original type-specimen, made by Geoffroy, is stated to be reddish at its base. It is true, that Geoffroy expresses himself in the following terms:—"Le corps est supérieurement recouvert, ainsi qu'on l'observe si souvent chez les Hapaliens, de poils roux dans la plus grande partie de leur étendue, annelés de blanchâtre et de noire vers la pointe. Il résulte de cette disposition, chez *M. pileatus*, un mélange de gris et de noir, mais non des bandes alternatives de l'une et de l'autre couleur." Although the adjective "roux" may not be perhaps a happy term, the rest of the description and the figure itself indicate an animal which does not differ essentially from the specimens examined by me in London, nor from my two mounted specimens here at Pará. Geoffroy evidently wrote with the desire to differentiate the uniform general colouring of this species (which, as already seen, is usually a common feature of most Amazonian Callitrichidæ) from the distinctly striped colouring of certain southern Marmoset Monkeys (*Hapale jacchus*, &c.).

On separating the fur of the back of my two individuals in the Pará Museum, the hair appears to be of the same deep blackish-brown as in the case of *M. griseoriventer*. The terminal fourth then shows a light greyish-white zone, followed by a terminal nearly black one. It follows therefore that in this detail my Purús specimens accord with the Juruá specimens of Ihering. However, this detail does not seem to me of sufficient weight to justify the establishing of a separate subspecies.

#### MIDAS MYSTAX Spix.

Acquaintance and description of this species date from the same period and come from the same source. Spix brought his specimens from the River Solimões; a female is figured on plate 22 of his work. Our Museum possesses a considerably darker male specimen from the River Juruá.

Instead of entering into a detailed description, I would simply call attention to the characteristic fact, that the white circum-buccal zone is nearly identical in extent and form with that of the preceding *Midas pileatus*, but with a stronger tendency to form a moustache.

**MIDAS ILLIGERI** Pucheran.

I have recently received, through the kindness of the wife of the German Consul at Pará, Dr. Olshausen, an example of another species of Amazonian Marmoset Monkey hitherto unrepresented in our collections. It had been obtained at a very early age from an Indian woman at Iquitos, and kept as a pet until its mistress was about to sail for Europe. It lived several months at the Museum until about half-grown, and is now mounted.

**DORSAL ASPECT.**—Principal colour a lovely dark brown-red covering the nape of neck, shoulders, and outer side of arms and legs, embracing with a small band the rump and base of the tail. The back, however, properly speaking, forms an exception to this colour, bearing a very long oval patch, distinctly outlined, of dirty black in the centre and greyish borders, with the tendency to form posteriorly dimly apparent light and dark transverse bands. Head, hands, feet, and tail black.

**VENTRAL ASPECT.**—Uniformly brownish-black from the throat as far as the anus, embracing the inner side of arms and legs, separated from the dorsal patch by a brownish-red margin.

In the black face we again find the white circumbuccal zone. But in this case it leaves the nostrils free and the white runs up to the cheeks in a triangular form nearly as far as the outer corner of the eye.

By this feature the animal immediately proves to belong to the group *b*, subdivision *a* of the classification of Schlegel ('Singes,' p. 262), that is to say to the *Hapale devillei* group. Among all the figures I have at my disposal, my specimen corresponds best with the animal represented in plate 13 of the 'Proceedings of the Zoological Society,' 1871, by Bartlett, with the designation of *Midas devillei* ♂ (considerably better than with the figure of *M. devillei*, fig. 3, plate 6, in the 'Atlas' of Castelnau, which lacks any trace of a distinctly coloured dorsal patch). As the animal there represented is attributed by Schlegel ('Singes,' p. 263) and by Forbes ('Handbook of Primates,' p. 145 *seq.*) to *Hapale illigeri* Pucheran ('Revue de Zoologie,' 1845, p. 336), and as the description of this species given by these two authors coincides satisfactorily with my Iquitos individual, I think I have to do with a half-grown specimen of *Midas illigeri* Puch., a Marmoset Monkey stated to be fairly abundant in the Peruvian Amazons.

February 5, 1907.

His Grace THE DUKE OF BEDFORD, K.G., President,  
in the Chair.

Mr. F. Martin Duncan, by permission of the Charles Urban Trading Co., Ltd., gave a cinematograph exhibition of animals in the Society's Gardens and other zoological subjects, chiefly the life-history of Insects.

Mr. Oldfield Thomas, F.R.S., F.Z.S., exhibited a collection of Mammals and Birds from the Islands of Saghalien and Hokkaido, N. Japan, made by Mr. Malcolm P. Anderson in carrying out the Duke of Bedford's Exploration of Eastern Asia. Mr. Thomas proposed to give a full account of the Mammals on a later occasion.

Dr. W. T. Calman, F.Z.S., read a paper entitled "On new or Rare Crustacea of the Order Cumacea from the Collection of the Copenhagen Museum. Part I. The families *Bodotriidae*, *Vauntompsoniidae*, and *Leuconidae*."

This paper will be published entire in the 'Transactions.'

The following papers were read :-

1. The Origin of the Lateral Horns of the Giraffe in Fœtal Life on the Area of the Parietal Bones. By E. RAY LANKESTER, M.A., D.Sc., LL.D., F.R.S., F.Z.S., Director of the Natural History Departments of the British Museum.

[Received February 5, 1907.]

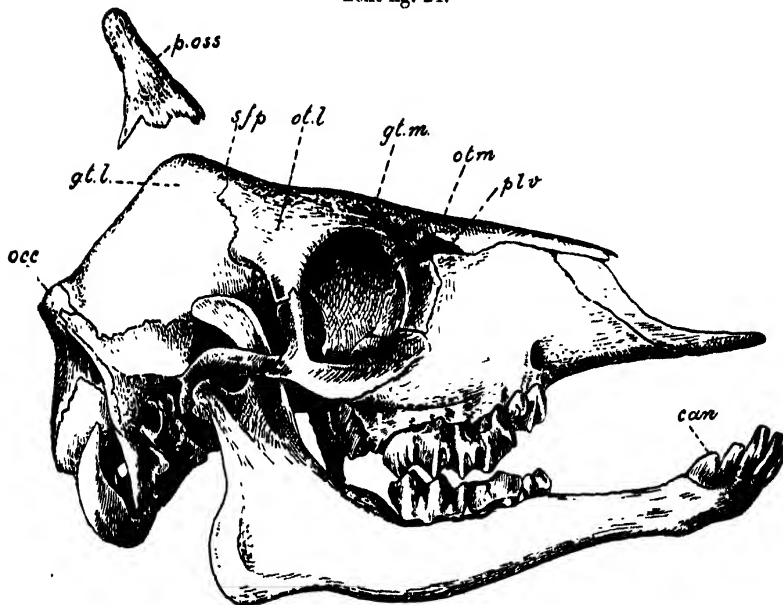
(Text-figures 24-36.)

A remarkable and wide difference between the Giraffe and the Okapi is constituted by the position and relation of the lateral horns in these two animals in regard to the bones of the skull. As I pointed out in my memoir on the Okapi read in 1901 (Trans. Zool. Soc. vol. xvi. p. 279), the bony horn-cone of that animal is attached to the frontal bone, and it is the frontal bone which is raised into a boss for its support, whilst even in the hornless skulls supposed to be those of the female these frontal bosses are present. On the other hand, in the young Giraffe the main axis of the lateral "ossicone"\* falls within the area of the parietal bone

\* I use the term "ossicone" in the present paper for the independently ossifying bony cones which are found in Okapi and Giraffe on the frontal and parietal areas and in the Giraffe also in a median position. In my memoir of 1901 I spoke of such structures as "ossicuspæ," a term which I now wish to apply more generally, reserving the term "ossicone" for the peculiar separately ossifying cones of the Giraffidæ.

(text-fig. 24). The wide-spreading base of the cone-like ossicone subsequently encroaches, it is true, over a large portion of the frontal bone. In the adult both the parietal and the frontal are

Text-fig. 24.



Lateral view of the skull and lower jaw of a very young Giraffe, measuring 30·8 centimetres from the occiput to the anterior border of the premaxilla: preserved in the British Museum. The drawing is five-twelfths of the natural size.

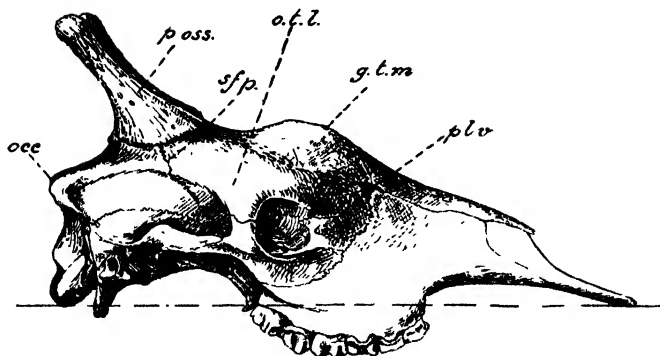
*occ.*, occipital crest; *gt.l.*, Giraffine conical tumescence of the parietal bone, above which is developed the lateral ossicone (*p.oss.*); *sfp.*, the fronto-parietal suture; *ot.l.*, position of the lateral tumescence of the Okapi, absent here; *gt.m.*, position of the median frontal tumescence of the Giraffe, which in this young specimen is still entirely undeveloped; *ot.m.*, position of the median tumescence of the Okapi's skull (basinasal); *pl.v.*, prelacrymal vacuity; *can.*, bifoliate canine (deciduous dentition).

(From Trans. Zool. Soc. vol. xvi. p. 293.)

enlarged and tumescent, and both enter largely into the composition of the lateral horn of the adult Giraffe (text-figs. 25 & 33). The whole form of the skull is rendered different in the two genera by this relationship of the ossicone to the frontal exclusively in the one, to the parietal primarily but not exclusively in the other (see text-figs. 26 & 27).

In a skull of a very young Giraffe (text-fig. 24), probably about a year old, preserved in the British Museum, the lateral ossicone is seen to rest almost entirely on the parietal. A transverse section (text-fig. 28, p. 104) shows that the anterior margin of the enlarging base of the bone constituting the ossicone has spread—

Text-fig. 25.

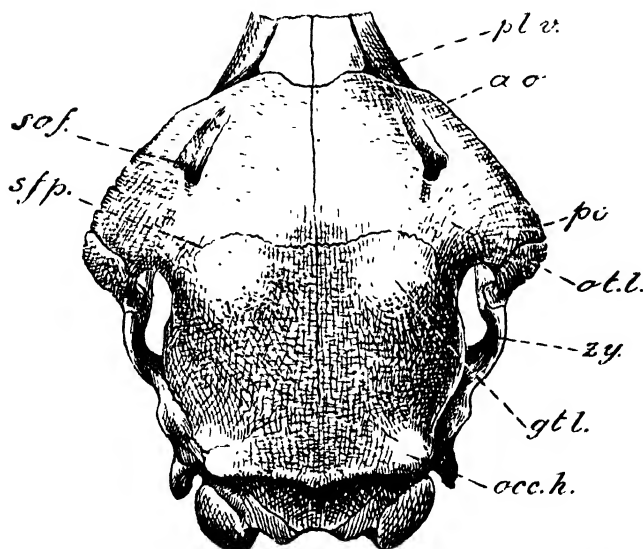


Lateral view of the skull of a Giraffe, about two-thirds grown.

*occ.*, occipital crest; *poss.*, parietal ossicone (epiphysis) overlying the parietal conical upgrowth and spreading on to the frontal bone; *sfp.*, fronto-parietal suture; *af.l.*, position of the lateral frontal tumescence in the Okapi, absent here; *g.t.m.*, the characteristic median tumescence of the Giraffe's frontal, devoid in this specimen of any secondary cap or epiphysis, absent in the Okapi; *pl.v.*, the prælacrymal vacuity.

(From Trans. Zool. Soc. vol. xvi. p. 284.)

Text-fig. 26.



View from above of the fronto-parietal region of the skull of a very young Giraffe. The parietal epiphyses were already ossified, but separable, and are here removed.

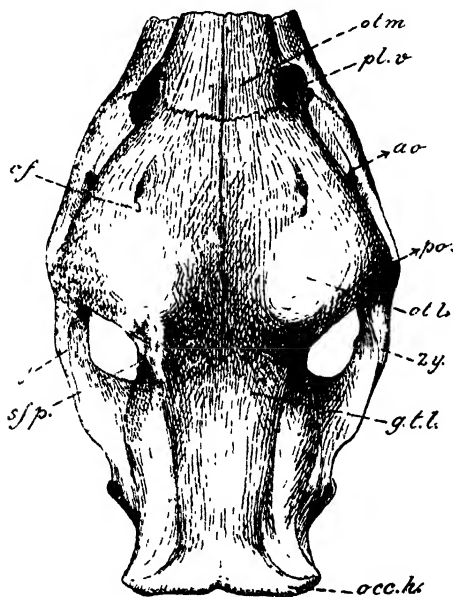
*occ.h.*, exostosis of the occipital crest, which in some adult Giraffes forms a second pair of "horns" (five-horned Giraffe); *gtl.*, the Giraffe lateral tumescence, seen here to originate in the parietal bone, which carries the conical ossicone and forms the Giraffe's paired "horns"; *ot.l.*, the position of the Okapi's lateral tumescence of the frontal bone, absent in Giraffe; *zy.*, zygomatic arch; *pu*, posterior angle of the orbit; *ao*, anterior angle of the orbit; *pl.v.*, prælacrymal vacuity; *sof.*, supraorbital fossa; *sfp.*, fronto-parietal suture.

(From Trans. Zool. Soc. vol. xvi. p. 291.)

invaded as it were—the area of the frontal bone to a very slight extent.

It seemed hardly possible to doubt that the ossicone of the Giraffe takes its origin within the area of the parietal bone, but that conclusion was forbidden by the explicit statement of the late Sir Richard Owen who, in a paper published sixty-seven years ago (1840) in the 'Transactions' of the Zoological Society, described a newly-born Giraffe which had died in the Gardens of the Zoological Society. Owen there states that he found the lateral horns of this Giraffe to be definitely attached to the *frontal* bone, and to that

Text-fig. 27.



View from above of the fronto-parietal region of the skull of an immature Okapi.

*occ.h.*, angle of the occipital crest; *g.t.l.*, position of the lateral tumescence of the parietal which supports the paired ossicones of the Giraffe, absent here; *o.l.*, the Okapian tumescence of the frontal which supports the paired ossicones of the Okapi; *zy.*, the zygomatic arch; *po.*, posterior angle of the orbit; *ao.*, anterior angle of the orbit; *pl.v.*, prælacrymal vacuity; *olm.*, the slight median tumescence of the base of the nasals of the Okapi; *sof.*, supraorbital fossa; *sfp.*, the fronto-parietal suture.

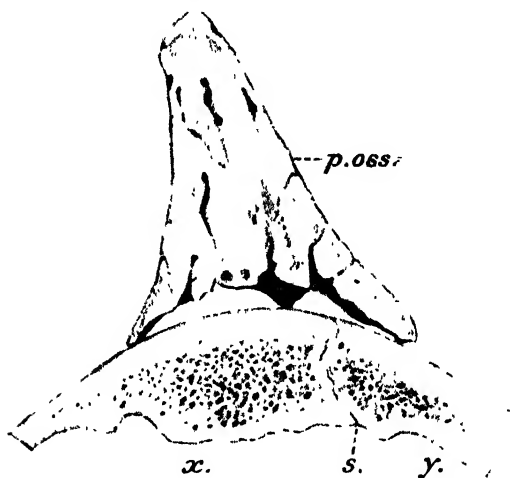
For comparison with text-figure 26.

(From Trans. Zool. Soc. vol. xvi. p. 290.)

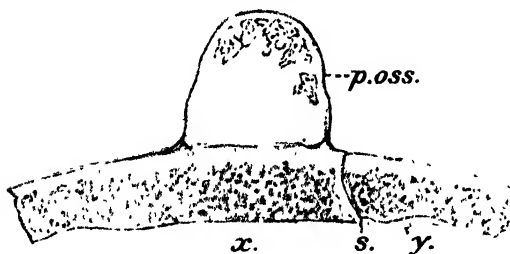
bone exclusively. He gives the drawing, which is copied in text-fig. 29, p. 104. He draws attention to the suture (*s*) separating the two bones seen in section, and he states that *x* is the frontal bone and *y* the parietal. He arrives at the conclusion that whilst the lateral horns of the Giraffe are seen thus to originate as do the horns of all other Pecora, in connection with the frontal bone,

yet that in the Giraffe the growing horn must spread from its original position, and in fact take up a new position on the parietal, with which he recognises that it is largely in contact in adult life.

Text-fig. 28.



Text-fig. 29.



Text-fig. 28.—Sagittal section through the bony tissue of the ossicone and the roof of the skull of a very young Giraffe (same specimen as that drawn in text-fig. 24). Drawn of the natural size.

*p.oss.*, the ossicone; *s.*, the parieto-frontal suture; *x.*, the parietal bone; *y.*, the frontal bone.

Text-fig. 29.—Copy of the drawing (natural size) of a sagittal section through the ossicone and the roof of the skull of a newly-born Giraffe, published by the late Sir Richard Owen in the Trans. Zool. Soc. 1840.

*p.oss.*, the ossicone; *s.*, the parieto-frontal suture; *x.*, stated to be a "frontal" by Owen but actually parietal; *y.*, stated to be "parietal" by Owen but now shown to be frontal.

I felt considerable doubts as to the correctness of this observation, and obtained through the kindness of Prof. Stewart some

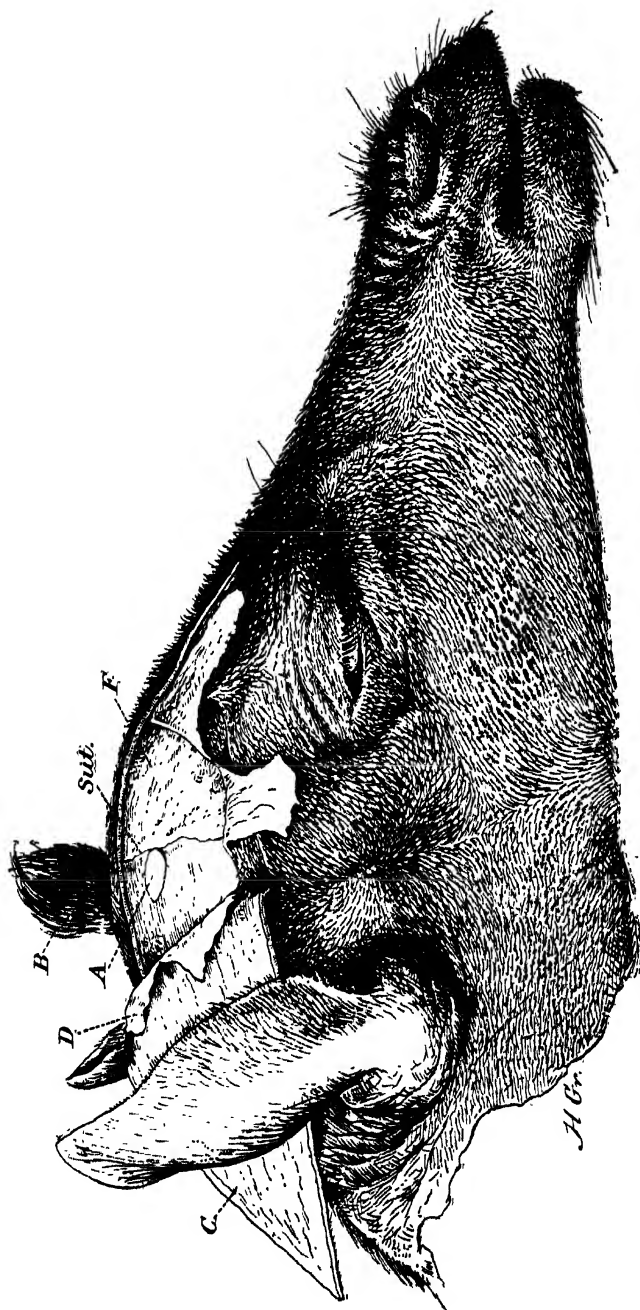
five years ago the actual skull of the newly-born Giraffe examined by Owen, and still preserved at the Royal College of Surgeons. The whole of the frontal and parietal regions had been cut away from the skull and the pieces could not be found. There was no evidence to be obtained from the specimen as to what really was the nature of the bone  $x$  (in text-fig. 29) and the bone  $y$ . I formed the hypothesis that Owen had had the horn-bearing region cut out and a section made by an assistant. The section is that which he figured and is here copied. But the piece having been detached from the rest of the skull, Owen seems to have mistaken right for left and back for front, so that in reality the bone marked  $x$  is the parietal and the bone marked  $y$  is the frontal; and the young horn or ossicone is resting on the parietal as it does in the later stages of growth, and not on the frontal as supposed by Owen.

I could not test the truth of this hypothesis without examining myself a newly-born Giraffe or a well-advanced foetus, and accordingly I have made efforts to obtain such a specimen by application to the officials of the late African Department of the Foreign Office and to those of the Colonial Office, as well as to naturalists and sportsmen. No newly-born or foetal Giraffe came to hand, nor could I hear of one as being preserved in any Museum in Europe. Accordingly I was very grateful when last summer our Secretary was able to place at my disposal the foetal Giraffe which was removed from its mother after her death in the Gardens in April 1906. This foetal Giraffe was figured and described in a general way by Mr. Beddard (Proc. Zool. Soc. 1906, p. 626), but the examination of the skull was kindly left to me. The dead mother of this foetus was a South-African (Transvaal) Giraffe (*G. camelopardalis wardi*) and the father a Kordofan specimen (*G. camelopardalis antiquorum*). Mr. Beddard has given the dimensions of the foetus, and has estimated that it had probably completed two-thirds of its foetal life. He has pointed out and figured the large size of the incipient lateral horns, and their free extremities tufted with long hair, and has noted that their substance is of a gristle-like consistency.

Soon after I received the specimen, the integument (C) was reflected from the right side of the fronto-parietal region of the head, under my supervision, by my assistant Dr. Ridewood; and by subsequent reflection of part of the periosteum the view obtained which is given in text-figure 30. The integument of the right side of the head (C) was thrown back, and the periosteum of the parietal bone was reflected (D) excepting that part lying beneath and forming the base of the right lateral horn. This was pinned down and cut away from the rest of the periosteum, leaving it as an oval area A, marking exactly the position of the ossicone (fibrous and soft) on the parietal bone. In the drawing the suture separating the frontal from the parietal bone is seen (*sut.*), and it is demonstrated that the base of the young lateral horn or ossicone is wholly within the area of the parietal bone, to the periosteum of which it is loosely attached by connective tissue.



Text-fig. 30.

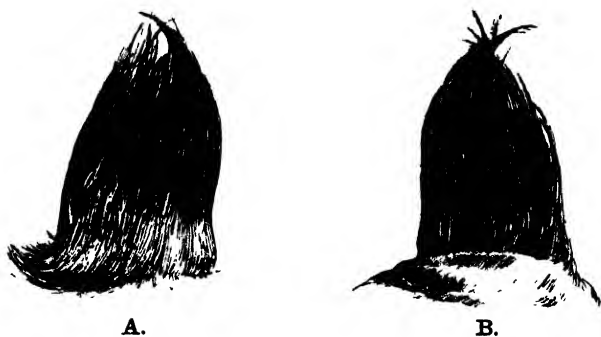


Drawing of the right side of the head of the fetal Gnu as described in the text, of three-fifths the natural size. The integument carrying the right "horn" has been reflected (C) and all of the subjacent periosteal membrane D, except an oval patch A corresponding exactly to the base of the right horn which is itself out of sight on the other side of the reflected flap of integument. F is the frontal bone; *Sut.* is the fronto-parietal suture; the naked bony surface upon which the oval patch of periosteum A is lying is the parietal bone; B is the hairy horn-rudiment of the left side.

The substance of the young ossicone was free from osseous deposit but of a tough consistence. Microscopic sections showed it to consist of a fibro-trabecular tissue with abundant interspersed cellular elements.

The dissection as here presented definitely establishes the fact that the site of origin of the lateral horns or ossicones of the Giraffe is entirely within the area of the parietal bone. The supposition that Sir Richard Owen had by inadvertence reversed the cut-out portion of the fronto-parietal area of his newly-born Giraffe, and had thus identified parietal as frontal and frontal as parietal, is confirmed. The importance of the distinction between the genus *Giraffa* and the genus *Okapia*, arising from the parietal position of the lateral ossicones in the former and their frontal position in the latter, is thus placed on a firm basis, since it is shown that at a stage of growth even earlier than that of birth the "forecast" or rudiment of the Giraffe's lateral bony cone (ossicone) is placed and attached absolutely and solely within the area of the parietal bone.

Text-fig. 31.



The left "horn" of the foetal Giraffe, drawn of the natural size.

A. Seen from behind (postero-external face).

B. Seen from in front (antero-internal face).

The form of the soft unossified forecasts of the lateral ossicones in this foetal Giraffe is worthy of further notice. As shown in Plate V. accompanying a later paper in this volume, and in the text-figure here given (fig. 31), the upgrowth is of considerable size, is compressed so as to give a narrow oblong area in transverse section, and is set on the head so that the elongated basal area has an oblique position, with its long diameter directed backwards and inwards towards the median line. The surface of the ossicone-forecast is covered with hair, which is very coarse and long at the free upstanding margin, as shown in text-fig. 31.

The text-figure 32 also shows that three of the dark hair-bands are disposed around the base of the young ossicone. The great

Text-fig. 32.



Diagram to show the flattened plate-like form and the orientation of the horns of the fetal Giraffe.

*a, b, c, d.* The four left-side inter-cornual colour-bands of the pelage.

lateral compression or flattening of the young structure is remarkable as compared with the fuller circular contour of a transverse section after ossification has advanced.

*Possible Relations of the Giraffid Ossicones to the bony Horn-cores of Bovidae and the Antlers of Cervidae.*

In my memoir describing Sir Harry Johnston's specimens of Okapi, I ventured on some speculations as to the relationships of the bony growths called horns and antlers in the Pecora. These speculations were vitiated by the uncertainty of existing knowledge as to the actual embryological origin of the structures compared. They assumed the origin of the horn-cores of Bovidae as separate rudiments which become united to the osteogenetic tissue of the frontal bone at an early period of development.

Although convincing histological accounts of their development are not yet in existence, it seems to result from the observations of Dürst that the horn-cores of Bovidae are not of independent origin, but are actual outgrowths of the osteogenetic tissue of the frontal bone. The same origin appears to hold for the horn-style or column which supports the antler of the Cervidae.

It is unfortunately the fact that our knowledge of the early embryological history of the "ossicones" of the Giraffe and Okapi is still more defective. All we know is (1) that in Owen's newly-born Giraffe the rudimentary unossified ossicone was separated (as shown in text-fig. 29) by the dense periosteal membrane from the subjacent parietal bone; (2) that in the fetal specimen of two-thirds time here described the soft forecast of the ossicone was equally cut off from the subjacent parietal bone by dense

periosteum; and (3) that in a much younger dried skull there is no indication on the cranial wall of any "outgrowth."

We shall not be in a position to speak definitely until other foetal Giraffes of younger stages have been examined by proper histological methods; but it seems legitimate to consider the lateral ossicones of the Giraffe, and therefore of the Okapi, as originating in a fibrous osteogenetic mass which gives rise to a protrusion of the integument and originates in the connective tissue of the integument rather than in the osteogenetic tissue of the cranial roof, from which it is separated by a dense membranous periosteum.

*The lateral ossicones of the Giraffe appear to have the same nature and mode of origin as has the centrally-placed ossicone of the same animal.* This median ossicone is variable in size, and does not appear until many years after birth when growth is nearly complete. The histological processes by which the median ossicone is formed have never yet been studied, but it is practically certain that it forms not as an outgrowth of the bone of the cranial roof, but as a "dermal" or tegumentary growth external to and independent of the cranial bone.

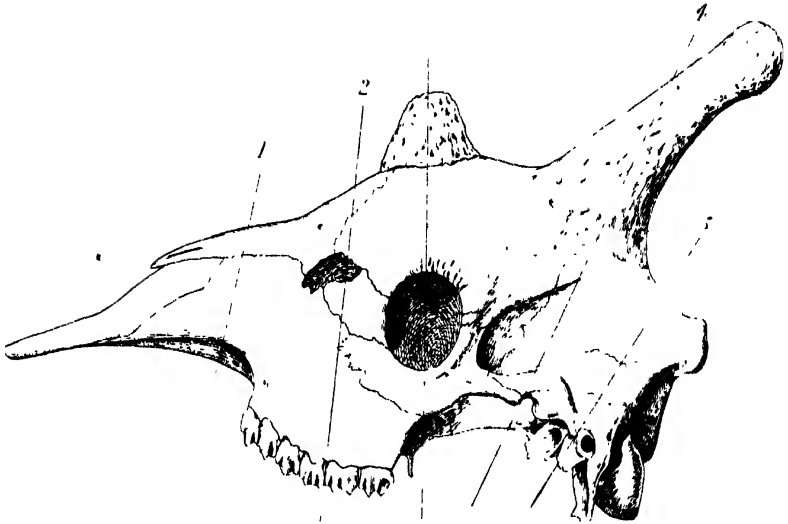
The same process which leads in the Giraffe to the formation of a median ossicone, in some cases becomes specially active and leads to the formation of additional "supernumerary" sub-tegumental ossifications. Thus two such of smaller size than the normal median ossicone are seen in the median line in a skull of Giraffe in the British Museum, in which bony deposits on the margin of the orbit are also seen. The skull of Okapi brought by Capt. Boyd Alexander from the Welle River shows such an exceptional sub-tegumental bony deposit on the margin of each orbit; and it is to be noticed that both in Giraffes and Okapis in old individuals the base of each ossicone spreads very widely as a thin encrusting layer, so as to involve much of the frontal in specimens of Giraffe and a large surface of the parietal in the case of Okapi.

These superficial ossicones and their outspreading marginal growths of the Giraffidæ cannot be accurately marked off in later life, although they can be separated in earlier life, from the highly important upgrowths or "tumescences" (as I previously called them) of the cranial bones over which they lie. The completed lateral horn of the Giraffe consists very largely of a conical upgrowth of the parietal bone, and also of the frontal bone—occupied by an air-sinus—developed between the tabulae of the bone. The basal region of the upgrowth involves the frontal bone more largely than the parietal. The originally independent ossicone contributes but a small amount to the whole bulk of the structure. It forms merely the terminal knob, and is fitted over the tumescence like a superficial investment which dwindles in thickness as it descends the cone until it becomes a mere film.

The position of the lateral and median ossicones in an adult

(though not senile) Giraffe, and the relation of the sinus of the parietal and frontal to the lateral horn, is shown in the figures (text-figs. 33 & 34) which were prepared from photographs of sections of a skull made under my direction. It will be observed that it is not possible in such sections to distinguish the line of ankylosis of the separate bones; we can only guess somewhat vaguely as to what belongs to each of the three elements fused together, viz., ossicone, parietal, and frontal.

Text-fig. 33.



Skull of Giraffe, left side; key-figure, a little larger than one-sixth (linear) of the natural size, showing the directions in which the skull was cut.

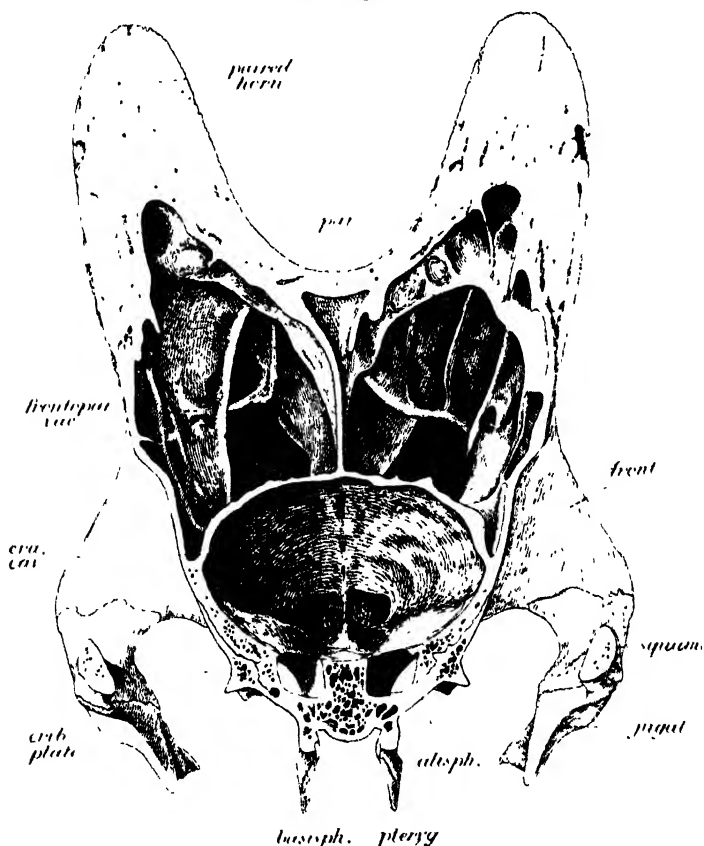
(From the Proc. Zool. Soc. London, 1904, vol. i. p. 151.)

Thus we see that the "ossicone" of the adult Giraffe is essentially but a cap of bony substance fitting over the great upgrowth or conical tumescence of the cranial wall—at the first most marked in the parietal area,—and that it makes its first appearance as a solid growth of fibrous tissue resting on the flat cranial roof. The same conclusion may legitimately be drawn from what we can see of the early and later conditions of the ossicone in Okapi\*.

\* The tumescence of the frontal bone of each side in Okapi, which ankyloses with the ossicone overlying it, is of considerable volume, like those to which the parietal gives rise in the Giraffe. I shall have an opportunity of describing this structure more fully hereafter. At the present moment I desire to draw attention to a curious fact with regard to the rudiment of a median horn in Okapi. The base of the nasal bone gives rise to a small but well-marked median tumescence in the Okapi. I described this in Sir Harry Johnston's specimen (Trans. Zool. Soc. vol. xvi.). In horn-bearing skulls of Okapi this is more pronounced than in the hornless specimens; it

Since it is clear then that the Giraffe's horns comprise two bony factors, the question arises which of the two corresponds with the horn-core of Bovidæ, or whether either or neither had such a correspondence.

Text-fig. 34.

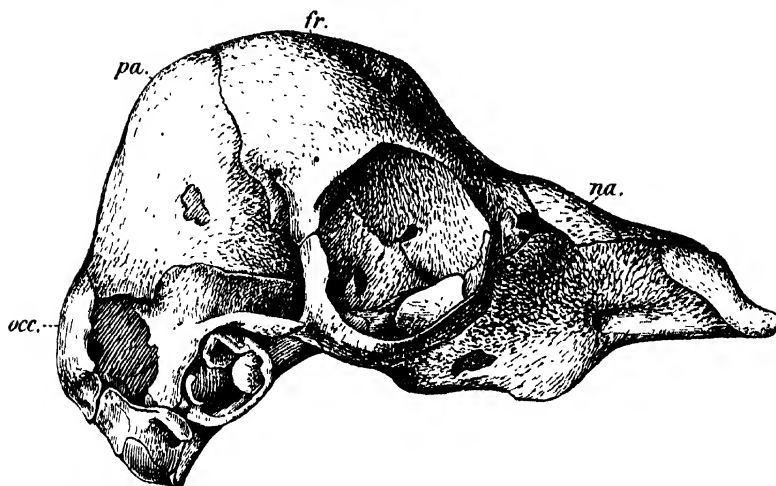


View, looking forwards, of the skull cut in the direction of the line 4 in text-fig. 33.  
One-third (linear) of the natural size.

(From the Proc. Zool. Soc. London, 1904, vol. i. p. 154.)

is more strongly marked in the horn-bearing skull of Okapi brought by Capt. Boyd Alexander from the Welle River than in any other specimen seen by me. No "ossicone" or tegumentary cap has been observed in Okapi in connection with this median tumescence. Has there been one present in the ancestors of Okapi? Or does the tumescence precede the formation of a tegumentary ossicone?

Text-fig. 35.



Drawing, of the natural size, of a young fetal skull of a Giraffe, preserved in the British Museum. The fetus is at so early a stage that no trace of the future horn or ossicone is presented, and moreover the parietal bone does not form the vertex of the brain-case as in the skull drawn in text-fig. 24, p. 101. It is worthy of remark that a line drawn from the occ.-par. suture to the fronto-par. suture is in this early fetal skull almost at right angles to a line drawn from the latter to the naso-frontal suture, a condition which is even more strikingly exhibited in the adult skull of the Common Ox (*Bos*) as contrasted with that of *Ovis*, *Oribos*, and Antilopidae. In adult Giraffe the surfaces of the frontal and parietal are more nearly parallel, and in *Okapia* quite so. It is a very curious fact that in *Bos* the whole posterior region of the brain-case formed by the parietals, which in *Okapia* stretches horizontally backwards from the fronto-parietal suture to a distance as great as that occupied by the frontal portion, is abolished! The parietals are vertical and not horizontal, and a sort of false occipital ridge is formed by the fronto-parietal suture. The very young Giraffe-fetus approaches this condition.

In answer to this question, it appears to me that the following statements are justified:—

1. Since the bony horn-core of Bovidae originates as a part of the osteogenetic tissue of the frontal bone, it cannot (according to our present knowledge) be identified without considerable qualification with the free tegumentary ossicones of Giraffidae.
2. The upgrowth (tumescence) of the frontal bone in Okapi and of the parietal and frontal in Giraffe, which forms the bulk of the lateral horns in those animals, is more nearly similar in nature to the bony horn-cores of Bovidae than are the ossicones of Giraffidae.
3. The *frontal* tumescence or upgrowth of Okapi cannot be considered as morphologically identical with the *parietal* tumescence or upgrowth of Giraffe.
4. The free lateral ossicone of Giraffe might legitimately be considered as morphologically identical with the free lateral ossicone of Okapi. The free tegumentary ossicone of an

ancestral form might in a series of generations shift its position from the frontal to the parietal area; and it might reasonably be admitted that the upgrowth or tumescence of the frontal ceased to develop when the parietal position was assumed by the ossicone with consequent tumescence and upgrowth of the parietal bone.

5. On the other hand, the theoretical assumption that the frontally-placed ossicone of Okapi and the parietally-placed ossicone of Giraffe are independent of one another and possibly co-exist in an ancestral form, is favoured by the fact that the Giraffe does develop a *third* well-marked ossicone in the mid-line of the frontal, and that both Okapi and Giraffe exhibit minute supernumerary growths of the kind on the cranial surface.
6. It results from these considerations that it is not possible at present to trace the lateral horns of the Okapi and the Giraffe into any close genetic relationship with those of Bovidæ—still less of Cervidæ. At the same time it is possible that the peculiar superficial element of the bony horn (the ossicone) is identical in the lateral horns of Okapi and *Giraffa*, having shifted its position backwards in the latter genus. This conclusion is not, however, by any means forced upon us since the Giraffidæ are known to have an additional ossicone—the median one; and it is therefore not without analogy that independent frontal and parietal ossicones should develop.

I am aware that it is not difficult to make assumptions by means of which a genetic relationship between the lateral horns of Giraffidæ, Bovidæ, and Cervidæ is rendered possible; but it should, I think, be clearly understood that there is at present no direct evidence to support these assumptions. It may be assumed (*a*) that a bony horn of the nature of the horn-core of the Bovidæ, or of the antler-column of Cervidæ, has in some remote ancestors of the Giraffidæ become segregated from the frontal bone of which it was a part, and acquired independent existence as a fibrous rudiment as well as independent ossification, thus establishing the independent lateral ossicone of the Giraffidæ. Or, again, it may be assumed (*b*) that in ancestors of the Bovidæ and Cervidæ, bony horns which were existing as free tegumentary products, ankylosing in mature age with subjacent cranial bones, became so ankylosed at earlier and earlier stages of development until all trace of their independent origin was lost, and they appeared to originate as growths of the frontal bone itself. The stock so endowed gave rise (it would be assumed) to Bovidæ and Cervidæ; that portion of the ancestry which retained the original method of development of free tegumentary ossicones became, on the other hand, the progenitors of the Giraffidæ.

I am not aware of any facts in the structure of living or extinct Artiodactyla which furnish an analogy for either of these processes of transformation. Nor do I think that our knowledge of the extinct forms such as *Samotherium*, *Helladotherium*, *Sivatherium*,



*Bramatherium*, and *Hydaspitherium*, is of a nature to assist in establishing the existence of such a remarkable transformation.

The assumption *a*—namely, that the transition was from frontal outgrowths such as Bovidæ and Cervidæ present, to the segregation and independence of the Giraffid ossicone—meets (it may be pointed out) with an almost insuperable obstacle in the free median frontal ossicone of the Giraffe, for which there is no forerunner in the Bovi-Cervine scheme of solid continuous outgrowths of the cranial wall. The consideration of the Lower Miocene *Protoceros* with its four pairs of horns does not help us much in this question, though its possession of a pair of parietal and of two pairs of frontal upgrowths or 'bosses' is significant.

*Various Positions occupied by the Paired Frontal Horns of  
Cavicorn and Cervine Ruminants.*

An interesting fact in relation to the question of the identification of Giraffe's parietal with Okapi's frontal ossicones is that

Text-fig. 36.

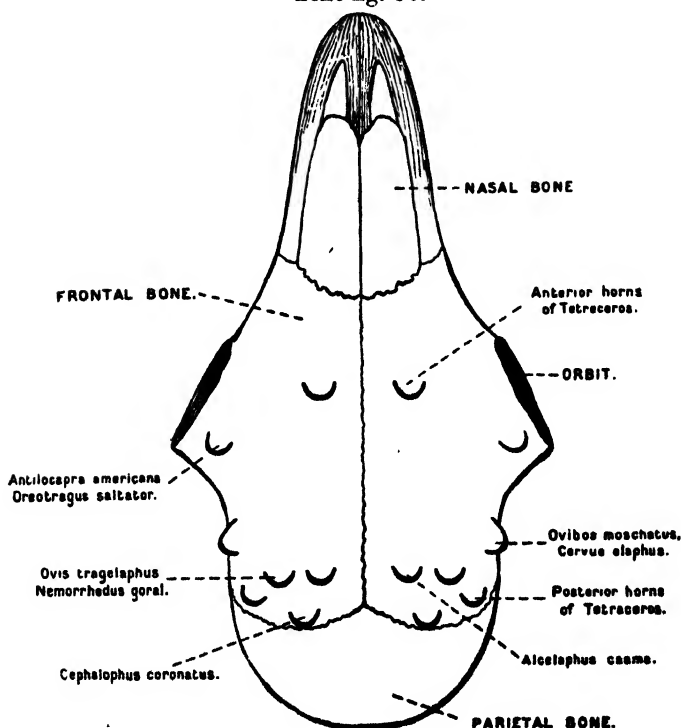


Diagram to show the various positions on the frontal bone at which the bony horn-cores of the Cavicorn and Cervine ruminants may take their growth. Though ranging widely over the frontals these upgrowths are never found as part of the parietal bones.





HEAD OF A FŒTAL GIRAFFE.

the paired frontal horns of Antelopes, Bovines, and Deer occupy very widely-separated positions in different genera. Dr. Ridewood has kindly prepared for me a diagram (text-fig. 36) showing these varied positions in a series of genera. The most remarkable position is that of the horn-cores of the Antelope *Cephalophus*, which is not fully exhibited in the diagram. The frontal in some species of this genus actually pushes out a process into the area of the parietal, upon which the horn-core rests. The horn-cores are seen (by reference to the diagram) to arise sometimes at the hinder margin of the frontal, sometimes on the orbital ring, sometimes in the anterior third of the frontal. The co-existence of two pairs in *Tetraceros* suggests a multiplicity of horns in ancestral forms.

The position of the horn-cores in the genus *Bos* is not marked in the diagram; it is identical with that of the posterior pair of *Tetraceros*.

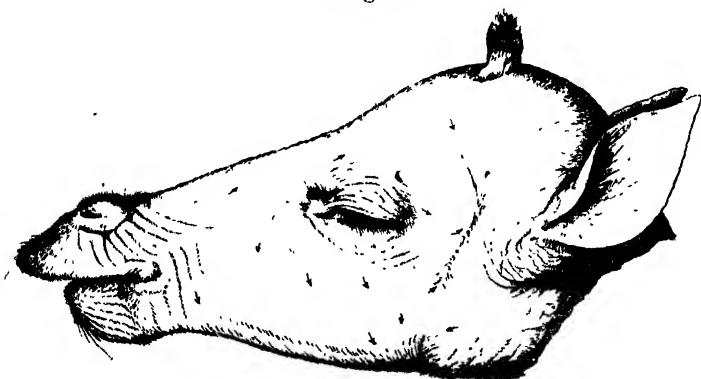
2. Parallel Hair-fringes and Colour-stripping on the Face of Foetal and Adult Giraffes. By E. RAY LANKESTER, M.A., D.Sc., LL.D., F.R.S., F.Z.S., Director of the British Museum (Natural History).

[Received February 5, 1907.]

(Plate V.\* and Text-figures 37-48.)

When examining the foetal Giraffe which I received from the Society in the past summer, I observed a number of parallel bands or stripes of dark and light colour on the hairy coat of the

Text-fig. 37.



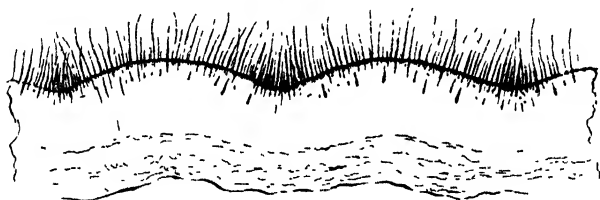
Left side of the head of the foetal Giraffe described, showing colour-stripes on the snout and above and below the eye. The small arrows indicate the direction of slope of the hairs. About three-tenths of the natural size.

\* For explanation of the Plate, see p. 125.

face—between the two lateral horn-sacs, also between the eyes and above the eyes, which are carefully represented in the coloured drawing (Plate V.) of the face of the foetal Giraffe. I observed similar but more strongly marked and broader bands of alternating reddish-brown and paler colour between the nostrils (see Plate V. and also text-fig. 30, *supra*, p. 106) and at the side of the upper lip, on the front of the lower jaw and below the eye (text-fig. 37, p. 115).

The colour-bands between the horns and the eyes varied in intensity according to the angle of the incident light, and could be temporarily destroyed by pressing the skin and smoothing down the hair. After careful examination of the hairs, I came to the conclusion that there was no actual difference of colour in the hairs occupying the darker stripes and those placed on the lighter tracts, but that the phenomenon was due to the existence of parallel linear depressions or wrinkles the existence of which was made obvious by a transverse section of the integument (text-fig. 38). The hairs are crowded together in the trough of the wrinkle, and further apart in the convex intermediate areas. That "wrinkling" could produce such an impression of dark and light banding was demonstrated by the casual folds and wrinkles of the integument on the legs, and by purposely producing such wrinkles by pressing or folding the hairy integument.

Text-fig. 38.



Section across three dark-coloured bands above the eye of the foetal Giraffe, showing three longitudinal furrows or depressions in transverse section corresponding to the dark bands. Magnified.

Nevertheless I could not attribute the colour-banding to a mere accidental or casual formation of wrinkles. Their definite form and arrangement precludes such an explanation. They appeared, to me to be the expression of a definite structural condition. Moreover, immediately over the eyes and on the snout the difference of colour of the alternating bands was very strong, the darkly-coloured stripes being of a strong reddish-brown tint and the intermediate bands quite pale; and in this case a pigment was present in the hairs of the darker stripes which was not so richly developed in those of the lighter neighbouring stripes. I found, on microscopic examination of the hairs, that they could be roughly divided into three sizes :

the largest, few in number ; medium-sized, more numerous ; and a smallest size, the most abundant (text-fig. 39). The two larger sizes of hair were remarkable for appearing almost colourless in their lower (proximal) moiety and very dark in the upper (distal)

Text-fig. 39.

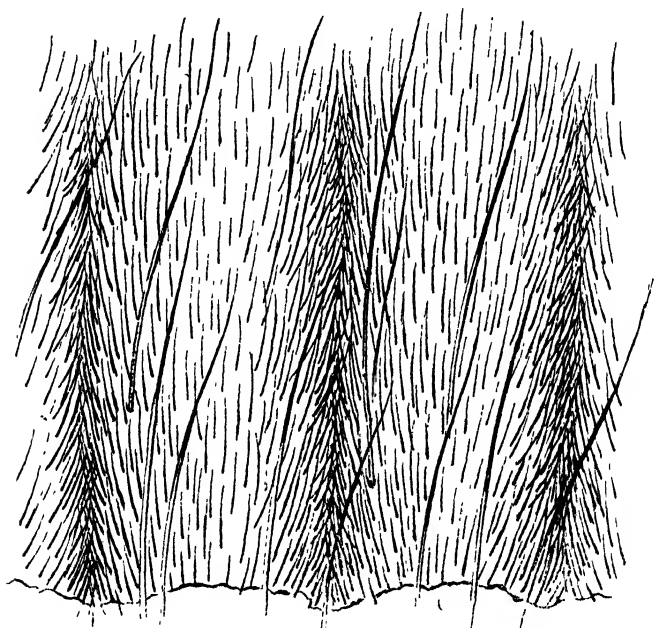


Section of the skin of the frontal region of the foetal Giraffe, showing three sizes of hairs. Greatly magnified.

moiety. The smallest hairs were dark-coloured throughout. When a piece of the hairy colour-banded region was examined with a strong lens, the tips of the hairs were seen to converge from the two sides of the shallow furrows or wrinkles as shown in the

text-figure 40. The superposition of the darker free ends of the hairs conceals their paler basal regions, and thus intensifies the difference between the apparent colouring of the troughs or wrinkles and the intermediate spaces where the hairs do not converge. An interesting experiment in regard to this matter was made by my assistant Dr. Ridewood. He took a piece of pale hat-maker's plush, and stained with dark pigment the free ends of its hairy surface. He found that on throwing this manufactured material into a series of wrinkles, very strong alternation

Text-fig. 40.

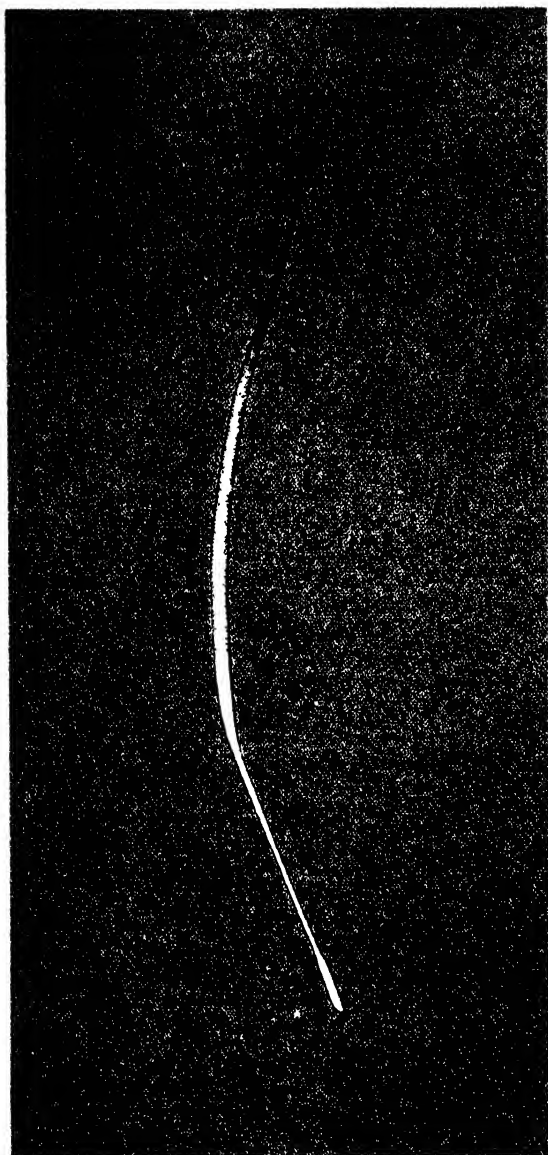


Surface-view of banded "pelage" of the frontal region of foetal Giraffe, showing the convergence of the hairs at the three longitudinal bands of dark appearance. Magnified.

of dark and light colour-stripes could be produced. (This prepared material was shown to the Meeting and dark and light bands produced in it and removed at pleasure by alternately throwing it into wrinkles and stretching it so as to remove the wrinkles.)

Although these colour-stripes on the head of the foetal Giraffe thus appear not to be due to alternate tracts of hair of differing colour, it seems to me that they have a real existence as effective colour-marking, and that their structural cause is to be found in the differentiation of the attachment of the panniculus carnosus

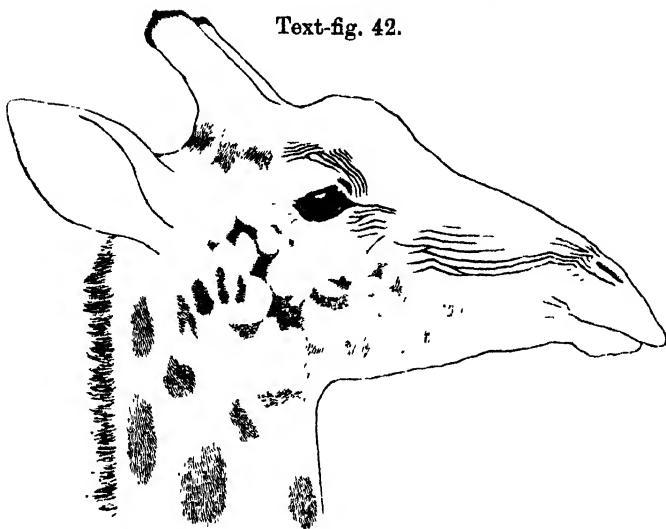
Text-fig. 41.



An enlarged drawing of a single hair of average size from the frontal region of an adult Giraffe (*Giraffa camelopardalis wardi*), showing the dark pigmented free extremity and the opaque white lower portion.

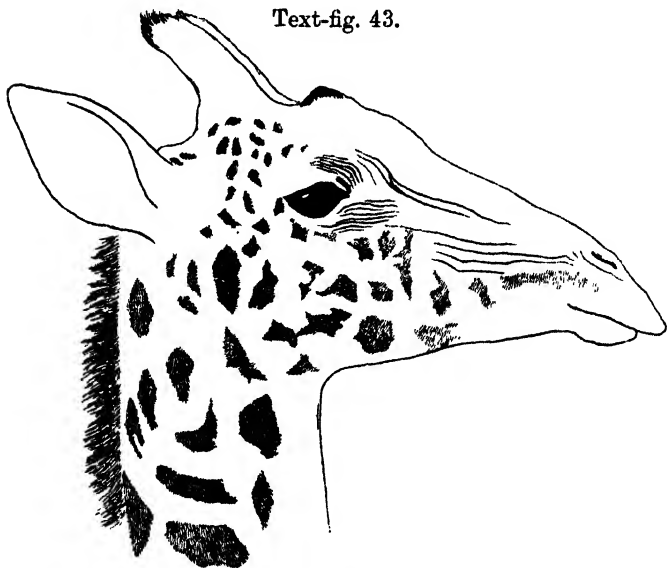


Text-fig. 42.



Colour-striping on the face of an adult male Giraffe from Kordofan (*G. c. antiquorum*).  
Drawn from a specimen living in the Society's Gardens.

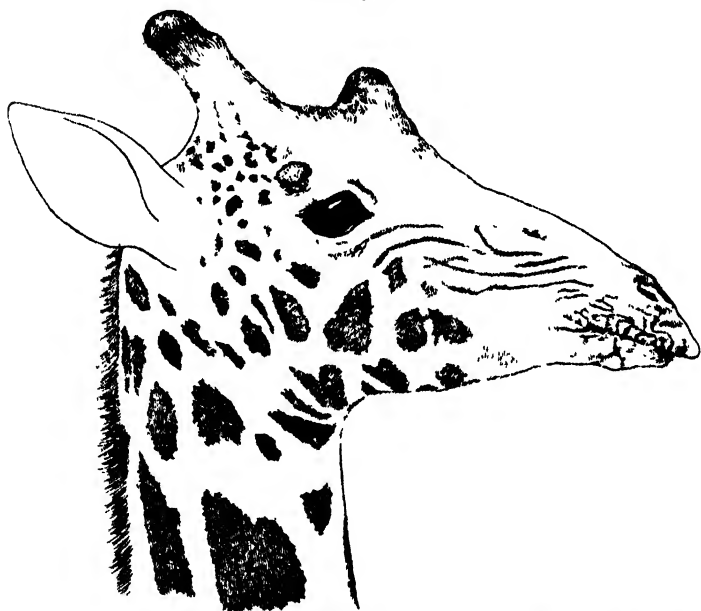
Text-fig. 43.



Colour-striping on the face of an adult female Giraffe from Kordofan (*G. c. antiquorum*).  
Drawn from a specimen living in the Society's Gardens.

to the integument, and in the related direction and convergence of the hairs in definite bands or hair streams. An examination of the adult Giraffe establishes the truth of this view. I visited the Giraffe-house at the Society's Gardens in order to examine the father of the foetal specimen in which I had observed this colour-striping. The father is a Kordofan specimen, and there is also in the Giraffe-house a female Kordofan Giraffe. I was not a little surprised to find very strongly-marked colour-striping over the eyes of both these Giraffes, especially well-marked in the female. Portions of the muzzle are also banded, and between the eye and the angle of the mouth are developed from four to six

Text-fig. 44.



Colour-striping on the face of *Giraffa camelopardalis cottoni* from Mt. Elgon, Uganda. This specimen shows a horn-like exostosis over the right eye. Drawn from a specimen in the British Museum.

strongly-marked horizontal colour-bands which are not present in the foetus (see text-figs. 42 & 43). I found that when the eye was shut and the skin above the eye stretched, the strongly-marked dark and light bands disappeared giving place to an irregularly blotched appearance\*, which immediately resolved itself into alternate dark and light bands when the eye was opened and the

\* It seemed to me that there were in this region definite tracts in which the pigmentation of the hair was pale, and others in which it was dark, but exact observation was, I found, impossible in the living animal.

superciliary region thrown into the normal condition assumed when the animal is alert. I also noticed that though the horizontal bands between eye and mouth never actually disappear, they are intensified by a muscular contraction resembling a sneer which sometimes is exhibited by the Giraffe. I found that the third Giraffe in the Gardens (a West African specimen) did not exhibit any colour-bands on the face.

Text-fig. 45.

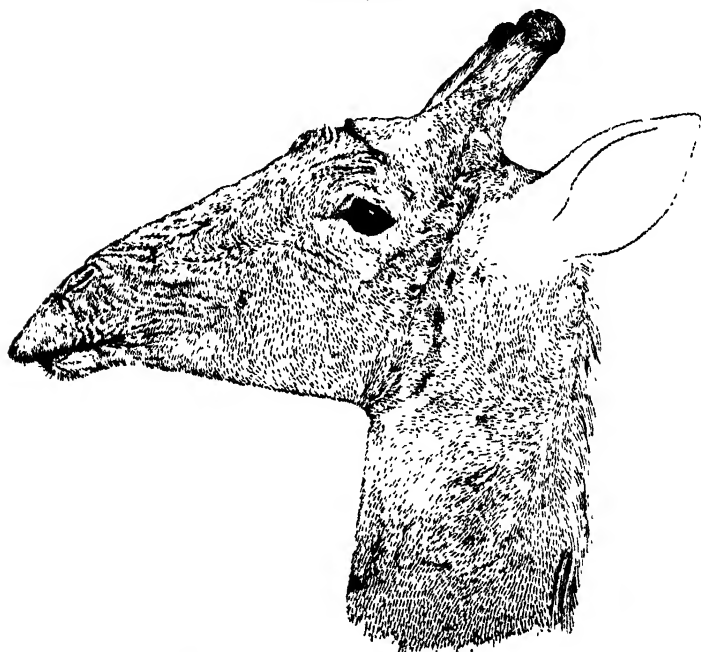


Colour-stripping of the face and muzzle of a Transvaal Giraffe (*Giraffa camelopardalis wardi*). Drawn from a specimen in the British Museum.

I next proceeded to examine from this point of view the fine series of Giraffe heads and necks exhibited in the public gallery of the British Museum, as well as several unmounted skins. I found that several of these specimens exhibit colour-banding over the eye and some of them below it, whilst these same specimens exhibit strong horizontal "fringes" or banding of the hair between the eye and muzzle, and some also show banding on the lower lip (see text-figs. 44-48). On the other hand, some of the specimens exhibit little or no trace of these bands. In none have I found any trace of the bands in the mediad position between the horns and between the eyes, shown by the fœtal specimen drawn in Plate V., which itself shows no trace of the pre-orbital horizontal stripes.

The bands of alternate light and dark colour are as much larger and wider in the adult Giraffe as are all its dimensions larger than those of the foetus. But a fact in regard to the banded appearance of the hairy coat of the face has come to light in the case of the adult skins which is indicated in the enlarged drawing of a piece of the foetal pelage (text-fig. 40, p. 118). This is that the bands are essentially due (at any rate, those which are peculiar to the adult and most strongly-marked, viz., the horizontal pre-orbital group of bands) to a differentiation of the hair into parallel tracts of more densely placed hairs, the points of

Text-fig. 46.

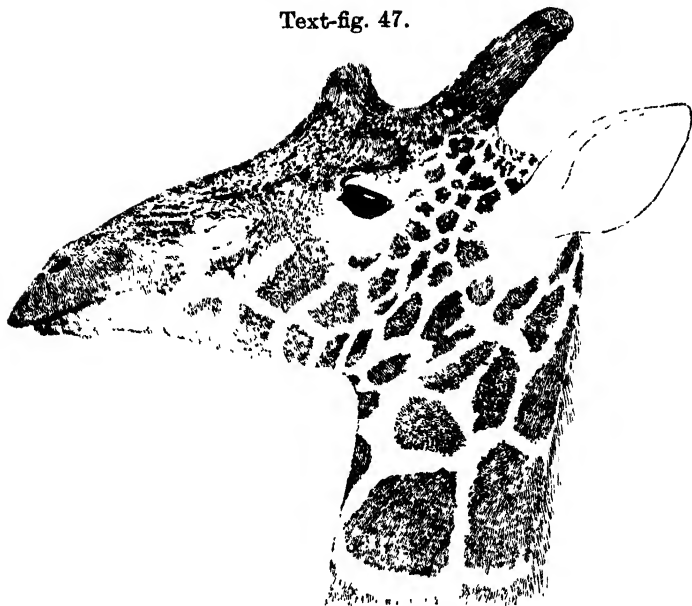


The same specimen as that shown in text-fig. 45. In this drawing the colour-effect is ignored, and only the ridge-like arrangement of the hair on the face and muzzle in parallel fringes is shown.

which converge and stand up so as to form a well-marked raised stripe, "fringe" or "ridge"\*, and intermediate tracts of smooth flat-lying hair. In some of the Museum specimens the more crowded upstanding hairs *appear* to be coloured more darkly than those of the intermediate tracts, but really the colour-effect is due to the pigment of the free ends of the hairs showing, whilst the thicker cortical substance of the bases of the hairs is white

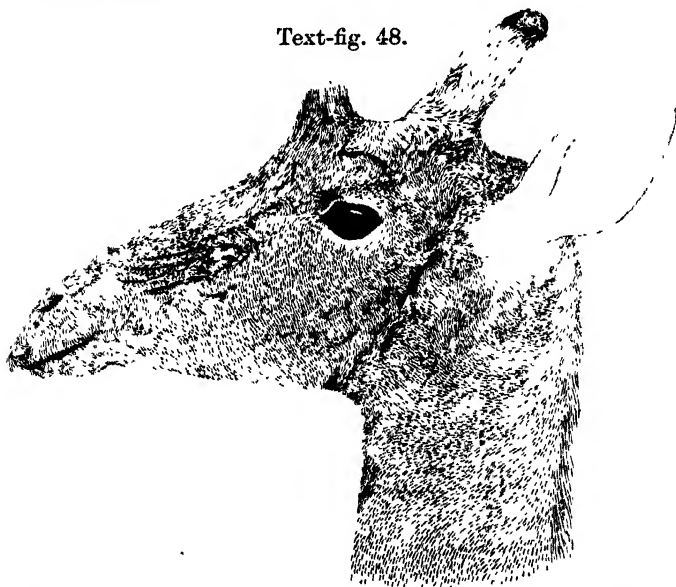
\* The *ridge* of upstanding hair corresponds, it must be noted, to what is a shallow wrinkle-like *groove* in the foetal skin.

Text-fig. 47.



Colour-striping (very slightly developed between eye and nostril) of the face of a Somali-land Giraffe (*Giraffa reticulatus*). Drawn from a specimen in the British Museum.

Text-fig. 48.



The same specimen as that shown in text-fig. 47, but with all colour omitted. The parallel bands between eye and nostril are not marked out in colour, but are merely elevated fringes or ridges of hair traversing a colourless region.

(text-fig. 41, p. 119). In one Somali specimen (*G. reticulatus*) the hairs are entirely white over a large part of the region of the face where the horizontal bands are developed. Yet these horizontal bands show up very distinctly on account of the more erect setting of the hairs (see text-figs. 47 & 48). In some cases the hairs of these ridges seem to have yielded more readily to destructive processes connected with taxidermy than have the hairs of the neighbouring tracts, and consequently the bands are marked out by nearly bald furrows or pathways.

Another point of interest is that one of the horizontal pre-orbital hair-bands in the adult Giraffe directly leads up to the pre-orbital hair-whorl, and that the position of this hair-whorl appears to be farther in front of the eye in the Somali *G. reticulatus* than in other Giraffes, whilst undoubtedly the hair is more erect and strongly developed on those ridges and on the hair-whorl in that species than in the other Giraffes which I have been able to examine.

It would be interesting to ascertain how far the varying development of these colour-bands and parallel hair-ridges on the face of the Giraffe is constant in the different local varieties of Giraffe which have been distinguished. This is not a matter with which I am at present able to deal. The purpose of the present communication is to call the attention of zoologists to a banded structure of the integument of the face in Giraffes which results in the appearance of dark and light parallel bands of hair and in the formation of strongly-marked parallel fringes or ridges of erect hair separated by bands of recumbent hair. These structures are recorded in a foetal and in adult Giraffes, and appear to have hitherto escaped attention.

The production of optically effective colour-bands by the mere crowding and direction of hairs along certain lines, without actual difference in the pigmentation of the hairs of the lighter and darker stripes, has possibly some significance in regard to the origin and development of the more definite striping of the mammalian pelage so frequently shown, when dark and light stripes distinguished from one another are caused by the actual presence of pigment in the hair of the dark stripes, and its absence in the hair of the lighter or white stripes.

#### EXPLANATION OF PLATE V.

Coloured drawing of the head and face, seen from above, of the foetus of a Giraffe removed from its mother which died in the Society's menagerie in April 1906.

The head of the foetus measured seven inches and one quarter from the anterior angle of the base of the outer ear to the extreme border of the upper lips.

The specimen had been preserved in alcohol for six months.

Details concerning the parentage &c. of this foetus are given by Mr. Boddard in Proc. Zool. Soc. 1906, p. 626.

3. On the Existence of Rudimentary Antlers in the Okapi.  
By E. RAY LANKESTER, M.A., D.Sc., LL.D., F.R.S.,  
F.Z.S., Director of the British Museum (Natural History).

[Received February 5, 1907.]

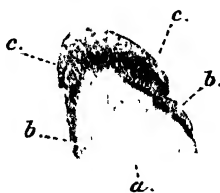
(Plates VI. & VII.\* and Text-figures 49–55.)

We know a great deal more as to the horns of the Okapi than was the case when I communicated my description of that animal to the Society in 1901, and founded the genus *Okapia*.

The two skulls sent home by Sir Harry Johnston—the first seen in Europe—were hornless, and it was at first a matter of doubt as to whether the Okapi was a hornless Giraffid, or whether the male possessed horns whilst these two skulls were the one immature and the other that of a hornless female.

During the printing of my memoir additional specimens were received in Brussels, and were transmitted to Dr. Forsyth Major in London for study and description. I saw in Dr. Forsyth Major's possession a fine adult Okapi skull which had a pair of well-developed bony cones rising each by a broad base from the frontals, of which they appeared to form part. No suture was visible. An outline of this skull was published in my memoir by kind permission of Dr. Forsyth Major. I also was able to examine and to mention the existence of a curious structure discovered by that gentleman in regard to these ossicuspis; and I described it in the following terms:—“The fine bony cones three inches long, which have made their appearance in the

Text-fig. 49.



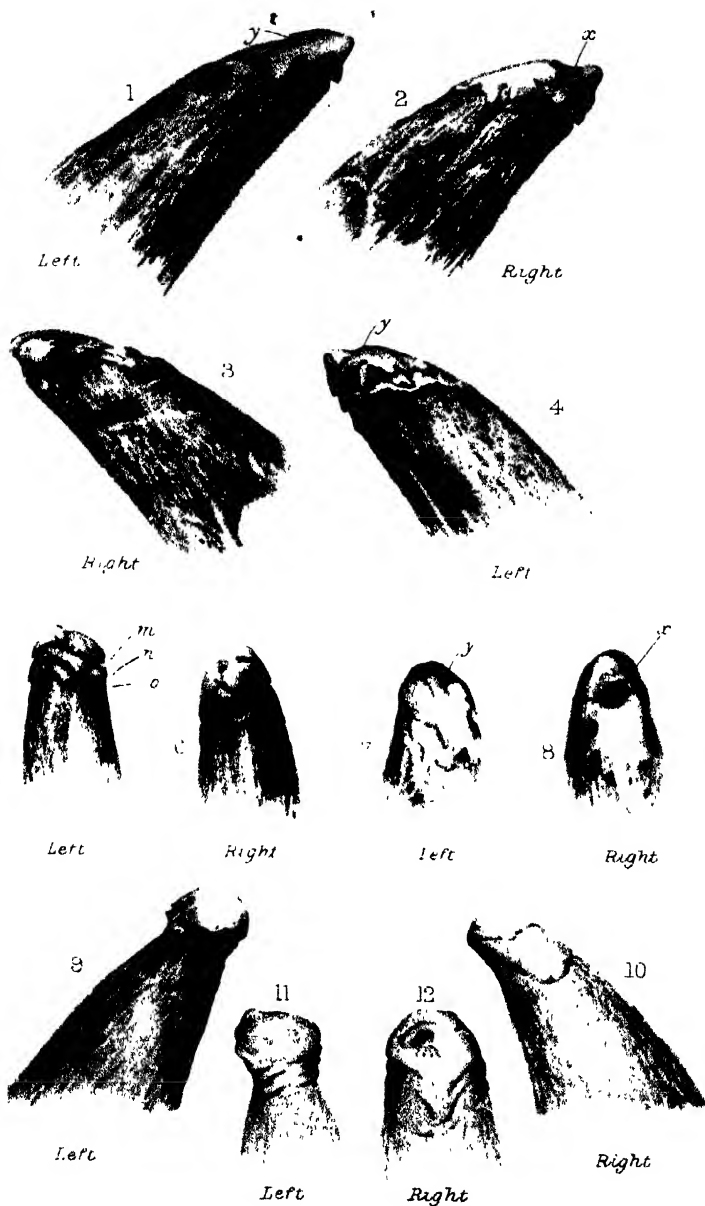
Drawing of a fore and aft section through the tip of the ossicone of an adult Okapi in the collection of the Museum of the Congo Independent State. The section and drawing were made by Dr. Forsyth Major.

The section shows the penetration of transverse fissures from the surface into the interior of the horn-tip.

*a*, dense ivory-like bone; *b*, posteriorly-placed transverse fissure; *c*, more anterior transverse fissure (marking off and presumably about to cut off and detach an anterior segment or plate of bone as a rudimentary “antler”)

Brussels skull, show no suture at their base, nor any indication of origin as separate cap-like structures. For all that one can see they may be direct outgrowths of the frontal bone itself. Curiously

\* For explanation of the Plates, see p. 134.

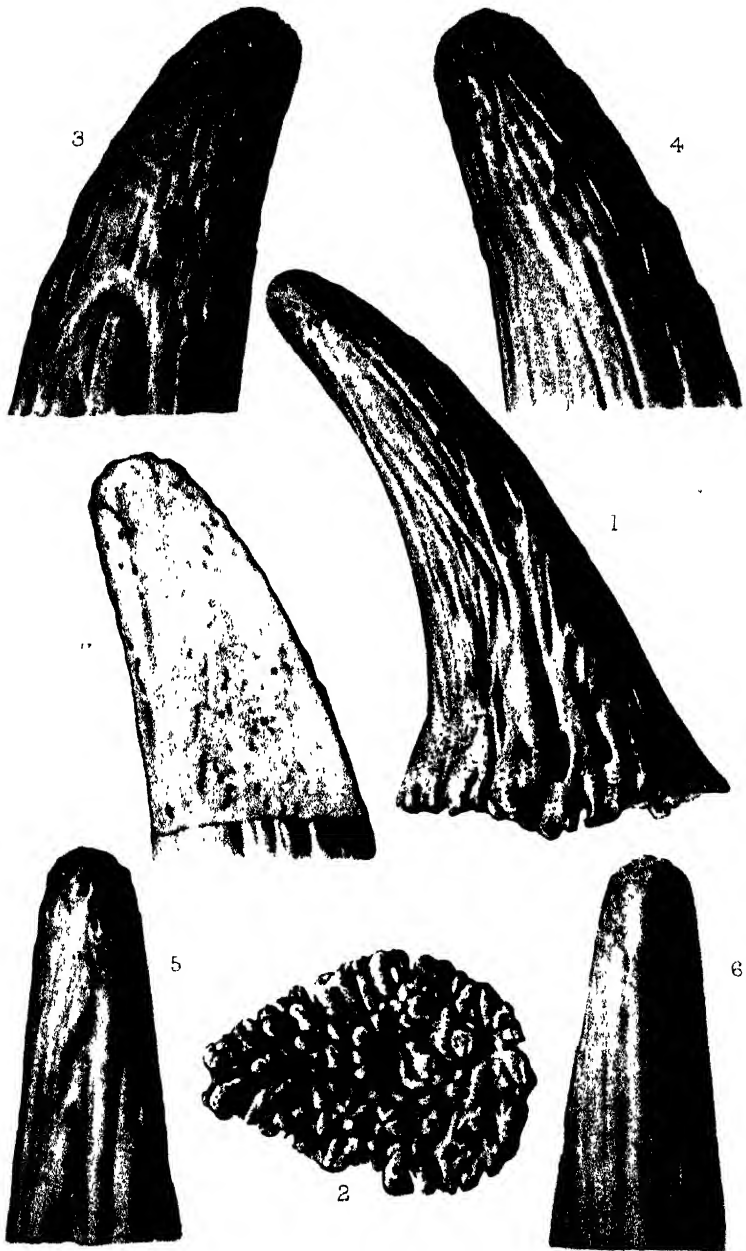


H Gronvold del

HORN-TIPS OF OKAPI.







G M Woodward del

London Stereoscopic Co. imp

YOUNG OSSICONE OR HORN OF OKAPI



enough, the point and posterior margin of the bony cone are polished as though it had protruded through the skin like a cervine antler. The point is separated by a suture from the rest of the 'ossicone,' forming a small terminal cap of bone a third of an inch in depth. This curious structure, as well as a possible second suture a little lower down the ossicone, was pointed out to me by Dr. Forsyth Major. These appearances will be figured in that gentleman's memoir on the Brussels' specimens." This is the first and so far the only published notice of the antler-like tips of the Okapi's horns. The figure prepared by Dr. Major of the section made by him through the end of this Okapi's ossicone is reproduced in the text-figure here appended (text-fig. 49). Dr. Major does not himself propose to publish anything further at present on the Okapi, and the little drawing has been placed in my hands by him. A tracing of it was also kindly sent to me by M. Fraipont, of Liège.

The further history of our knowledge of the horns of the Okapi has been complicated by the arrival in Europe of various specimens, concerning the sex of which either erroneous information or none at all has been given by the natives from whom the specimens were obtained. Thus Dr. Forsyth Major was led to suppose that the female Okapi has a small unattached ossicone, some two inches in length, when adult, but he subsequently came to the conclusion that this supposed female was in reality a young male. In 'La Belgique Coloniale,' No. 21, May 1902, Dr. Forsyth Major wrote:—"L'Okapi possède deux cornes frontales, recouvertes d'une peau velue, plus petites, de forme conique et presque verticales chez la femelle; plus grandes, dirigées obliquement en arrière et en peu triangulaires chez le mâle."

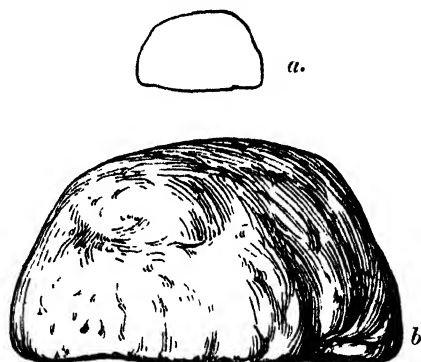
At a subsequent date Dr. Forsyth Major came to the conclusion that the specimen supposed to be a female possessing small detached ossicones, was in reality a young male (Proc. Zool. Soc. 1902, ii. p. 339), and that the female Okapi is hornless, whilst the male alone possesses "horns" which make their appearance as separate conical structures, ossifying independently of the subjacent bones (as in the Giraffe) and becoming firmly ankylosed to the frontal bone in the adult—a boss-like upgrowth of which enters into the structure of the complete horn.

There is little room for doubt that this is the true account of the matter, though we still are in want of full information as to the characters of the adult female Okapi\*. In a subsequent communication I shall be able to give more precisely the characters of the two types of skull, supposed to be that of the horn-bearing male and the hornless female, respectively. The skulls carrying an ankylosed or merely loosely-attached bony cone on the frontals

\* Owing to the uncertainty which exists as to the origin of skin and skull which are sometimes sent home from Africa as belonging to one individual, whereas they undoubtedly in certain cases belong to distinct individuals, it is still doubtful as to whether the female Okapi has or has not in the adult condition a small knob-like protuberance of the integument, separable from the subjacent bone and representing the horn of the male.

(supposed to be those of males) are longer and narrower than the equally large or larger skulls devoid of any bony cones in connection with the frontals (supposed to be those of females) \*. Whatever opinion is held, or whatever decision may be ultimately arrived at in regard to these two types of skull, it is the fact that they are very distinct from one another and that all the Okapi skulls which I have examined can be definitely assigned to one or the

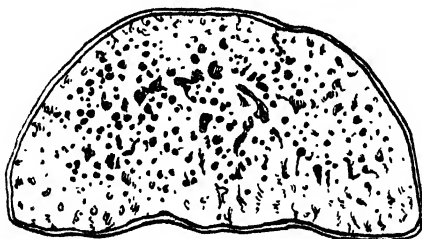
Text-fig. 50.



Rudimentary free ossicone of hemispherical shape from the skin overlying the frontal bossed region of the skull of an Okapi of the broad-skulled type—sub-adult (deciduous molars very much worn, premolars not yet visible; third lower molar in use on both sides, fifth cusp shows slight wear).

*a*, natural size; *b*, enlarged.

Text-fig. 51.



Section of the ossicone drawn in text-fig. 50, to show the incomplete ossification.

other of these two types. There is no third form known. The two types may perhaps be best distinguished as *O. johnstoni* (the name I gave to the broad hornless sub-adult skull accompanying

\* One of these broad-skulled specimens has, however, been found to possess a pair of completely detached bony ossicones of minute size embedded in the integument. The specimen is a little older (as indicated by the dentition) than Sir Harry Johnston's larger individual (that mounted in the British Museum), but is not quite adult. It belongs to Messrs. Rowland Ward. I give here figures of the minute ossicone (text-figs. 50 & 51).

the skin sent home by Sir Harry Johnston) and *O. liebrechtsi*, the name given by Dr. Forsyth Major to the more elongate and narrow type of skull, which is that usually provided with bony cones attached to or ankylosed with the frontal bones. It is important to note that Dr. Major figures a skull (Proc. Zool. Soc. loc. cit. p. 423) which is hornless and is regarded by him as that of a female of the elongate type, *O. liebrechtsi*. I hope shortly to publish some measurements and outlines of these two types of skull. I have examined three of the *O. johnstoni*-type, and five of the *O. liebrechtsi*-type. Though there is considerable variation in the number and breadth of the white stripes on the fore and hind limbs of the skins of Okapi received in this country (including the excellent specimens obtained independently by Major Powell Cotton and by Captain Boyd Alexander from widely separated localities, the former from the Ituri Forest, the latter from the Welle River), I have seen no evidence that a different striping of the skin is associated with the difference of skull-form. On the contrary, there is positive evidence that the striping of the skin is very nearly identical (though no two specimens are exactly alike) in animals which possessed the *liebrechtsi* form of skull with that exhibited by the mounted specimen (*O. johnstoni*) with hornless skull, sent home by Sir Harry Johnston, figured by me, and now in the British Museum. Nevertheless, it is true that direct and convincing evidence is as yet wanting for the conclusion that *O. liebrechtsi* is merely the male of *O. johnstoni*.

When I had an opportunity (in 1904) of examining the fine skin of the adult (supposed) male Okapi, presented by the Congo State to the Museum of Paris, which is set up in the public gallery there, I was especially anxious to note the state of the horn-tips. I found that they were represented in the mounted specimen and were seen projecting through the skin which clothed the "ossicone" up to a limit of about half-an-inch from the tip. From this level the dense bony matter was naked. It showed in each horn two fine transverse grooves, as in the ossicone examined and sliced by Dr. Forsyth Major. This went far to prove that the condition noted by him was not exceptional or morbid, and accordingly I have examined the ossicones of other specimens of adult male Okapis, as opportunity occurred. Several skins and imperfect skeletons have been received in London by dealers in zoological specimens, and I am especially indebted to Messrs. Rowland Ward & Co. for the opportunity of examining the ossicones of four adult Okapis. Of two of these individuals I have had the ossicones drawn (Pl. VI.) so as to show the free termination from different points of view. The two other specimens examined by me presented the same remarkable appearances as those figured, and as shown by the Paris Okapi, but I was unable to procure carefully drawn figures of them. Thus, including the Brussels skull examined by Dr. Forsyth Major, I have ascertained the existence of these transverse grooves or fissures in six adult male Okapis. I have

also evidence of their existence in a plaster cast of another specimen which passed through the hands of Messrs. Rowland Ward & Co.

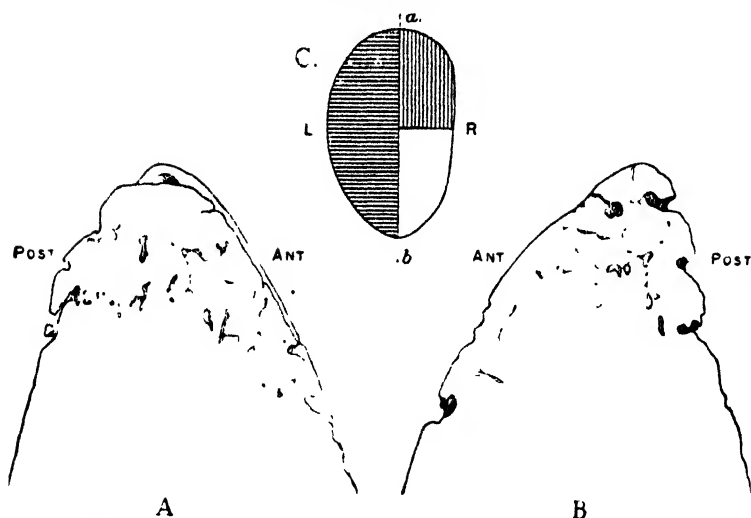
An examination of the figures given in Plate VI. shows that in all four ossicones (the right and left of two adult male Okapis) the free terminal region is smooth and polished, forming a cap of about half an inch in length, whilst this region is followed by a rougher substance, furrowed on the surface. The polished region projects beyond the skin, the rougher region is clothed by the living integument. In all there are very deep horizontal fissures in the polished material of the "cap." These fissures are somewhat irregular in form, and it is impossible without making a section (which I had not permission to do)\* through the solid material to ascertain their depth. They are of the same nature as those shown in the text-figure in section (text-figure 49, p. 126).

I think there can be little doubt that these transverse fissures are caused by the ingrowth of the living tissue after the protrusion of the dense polished cap, so as to cut off the protruding portion and provide for its breaking off—just as an antler is cut off and prepared for disruption in the Cervidæ. A small conical piece is thus thrown off from the end of the horn or ossicusp, and may be regarded as a rudimentary or minute "antler."

But the process of discarding these minute points or antlers in the Okapi appears to differ from what occurs in the Cervidæ, not only in the minute size of the discarded segments, but in the fact that the preparation for the breaking off a second (and even a third) segment takes place before the first piece has been got rid of. The living tissue having absorbed the bony matter by a horizontal ingrowth and having created a transverse break in the continuity of the osseous substance (see text-figure), recedes for a distance of a sixth of an inch or less, and then again penetrates inwards, forming a new horizon of disruption; and from the appearance of the specimens figured in Plate VI., especially figs. 4 and 5, it seems that this process of the recession of the living investment of the horn-tip and the subsequent ingrowth of the living tissue, may be again repeated before the most anterior piece is broken off, so that these horizontal fissures are visible on the surface of the horn-tip, following one another somewhat irregularly.

\* Since reading this paper, I have been kindly permitted by the authorities of the Royal Scottish Museum to examine the horns of one of the specimens above referred to by making a section of the tip of the horn. The piece cut out has been drawn and then carefully replaced and cemented in position, so that no injury is done to the specimen. The skull lent to me by the Royal Scottish Museum is that of which I had already drawn the horn-tips in figs. 1 to 8, Plate VI., before it had passed from the possession of Messrs. Rowland Ward & Co. The sections drawn on an enlarged scale in text-figs. 52 & 53 explain themselves. It is seen that the grooves or fissures visible on the surface do not extend very deeply, but that there is evidence of resorptive activity in the form of certain branching canal-like structures lying deeply within the bony matter, which have probably been excavated by resorptive ingrowths from the soft surface tissues.

Text-fig. 52.



The diagram C shows the direction in which certain cuts have been made in the left osseous horn (ossicone or ossicusp) of the Edinburgh Okapi (also illustrated in Pl. VI. figs. 1 to 8).

*a*, anterior border; *b*, posterior border. L, left side; R, right side.

A is a drawing three times the natural size of the cut surface of the bisected horn, the bisection being effected in a plane erected on the line *ab* of the diagram C. It shows the eating in of the transverse fissures into the dense bony substance, and a number of irregular spaces and fissures which are probably cavities due to re-sorption of the bone. B is a drawing of the other half of the same bisected horn-tip.

Text-fig. 53.



Drawing of three times the natural size of the surface of a section obtained by cutting half of the same bisected horn-tip through a plane erected on the line *R* of the diagram, separating the shaded from the unshaded area. The penetration of the transverse fissures is shown. The cavities *m*, *n*, *o* correspond to the transverse fissures labelled *m*, *n*, *o* in fig. 5 of Plate VI., representing the same specimen before it was divided.



We have no knowledge or indication that the shedding of these demarcated segments of the horn-tip is seasonal, nor indeed of the actual occurrence of such a shedding. However, the animal which is referred to in the explanation of Plate VI. as specimen A, shows in both right and left horn-tips a well-marked concavity, such as would correspond to the scar left by the "shedding" or breaking off of a previously existing cap or segment of the dense bony substance. In fig. 2, this is seen in a view of the mediad (inner) face of the *right* ossicusp, and is marked *x*. In fig. 8 the same cavity is seen (and marked *x*) in a view taken from in front of, and somewhat above, the same horn-tip.

It seems to me that we have in these appearances of the Okapi's free or naked horn-tip (external termination of the ossicone) the evidence of a process of the same physiological significance as that seen in the seasonal removal of the antler in the Cervidæ. The continued contact of a deep tissue such as bone with the infective material of the outer world cannot be tolerated: necrotic organisms must effect a lodgment and gradually extend their ravages into the whole tract of the ossicone, and even to the bones of the skull. Accordingly, the exposed "tip" is cut off by a bone-absorbing ingrowth of the living tegumentary tissue, and the process of autotomy is active and recurrent. In the Okapi the process appears to be less elaborated and regularised than in the Cervidæ, and we do not know at present the details of its commencement or its final development. It is, however, certain that up to a late stage of growth, when the male Okapi is nearly of full size, the ossicone has not penetrated the integument with its tip, and that there is no indication of the polishing of the ossicone's tip nor of transverse fissures caused by absorbent ingrowths of soft tissue. This is demonstrated by the ossicone of a male\* Okapi of nearly full growth (the last molar of the upper series being not yet in use and the premolars only recently having superseded their deciduous fore-runners), which is illustrated in Plate VII. This specimen belongs to a very perfect skeleton obtained, together with the skin, by Major Powell Cotton in the Ituri Forest, which is now in the British Museum (Natural History) at Cromwell Road. The ossicone figured is that of the right side. It is larger than that of the left side, weighing 31.45 grammes as against 28.15 grammes scaled by the left ossicusp. This asymmetry of the ossicusp of the Okapi, and a difference in the direction of the slope of these structures when right and left sides are compared, is to be observed in skulls of adult male specimens, and was mentioned by me in my memoir of 1901.

The ossicones in Major Powell Cotton's specimen have not yet

\* Major Powell Cotton ascertained that this specimen is a male, by an examination of the genital organs, and the skin prepared under his direction retains the external genitalia.

ankylosed with the frontal bone, but show an expanded base with radiating trabecular structure of the bony material (see fig. 2, Pl. VII.); a peculiarity of surface which is repeated by the enlarged area of frontal bone upon which they rest—a condition which occurs also in young Giraffes. As shown by the drawings in Plate VII., there is no evidence in this ossicone of polishing or sharpening of the apex. The rough longitudinal grooves and furrows are continued to that region, and there are no transverse fissures. A vertical section (fig. 7, Plate VII.) of the apical region shows a very dense bony structure, but no trace of ingrowths from the surface. We may take it that this ossicone was still entirely covered in by the vascular living integument, as is the ossicone in the Giraffe throughout life. It furnishes us with a stage immediately antecedent to the fixation of the ossicone by ankylosis to the frontal bone, and antecedent to the breaking through of the integument by the apex of the bony cone.

We may imagine the subsequent stages in the history which connect this specimen with those figured in Plate VI. The rubbing, polishing, and pointing of the ivory-like apex by use, the first horizontal ingrowth of the lacerated investing integument, the recession of that living investment after having established one horizontal discontinuity or plane of disruption of the dense bone, and the subsequent invasive ingrowth to form a second and by repeated recession and ingrowth a third such plane of disruption, and probably yet others.

In conclusion, I would point out that it is quite conceivable that this cutting off of a series of antler-like tips from the ossicone of the Okapi, is a process independently set up in this Giraffid animal, having a similar physiological explanation to that which applies to the similar process familiar to us in the Cervidæ.

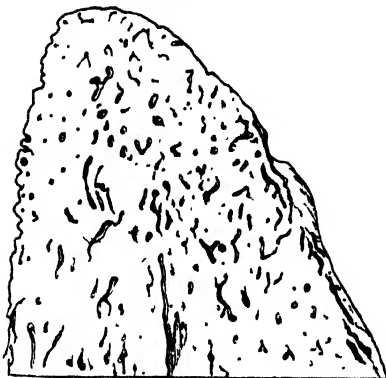
The different views which may be entertained, in the present state of our knowledge of the facts of embryology and early growth, as to the inter-relations of the ossicones of the Giraffidæ, the antlers of the Cervidæ, and the bony horn-cores of the Bovidæ, are briefly stated in the preceding memoir on the "Origin of the Lateral Horns of the Giraffe," and to this I would now refer the reader.

[April 1907.—I add here text-figures (54 & 55, p. 134) of the ossicone of the specimen of Okapi brought home by Capt. Boyd Alexander from the Welle River and presented by him to the National Collection. There are many interesting features about the skin and skull which we owe to Capt. Boyd Alexander, and these I hope to describe hereafter. The horn or ossicone is that of an animal a very little younger than Major Powell Cotton's (as inferred from the dentition). It is intermediate in size between that drawn in text fig. 50 and that figured in Plate VII. Its bony substance is much less dense and ivory-like than that of

Text-fig. 54.



Text-fig. 55.



Text-fig. 54.—Drawing of the right ossicone (not yet ankylosed) of the Okapi brought by Capt. Boyd Alexander from the Welle River.

The relative age of this Okapi is indicated by the fact that whilst the deciduous molars are still in place in every socket, yet they are very much worn and *all* the true molars in both upper and lower jaw are “through” and moderately worn.

Text-fig. 55.—Section through the tip of the same specimen to show the incomplete trabeculated ossification, contrasting with the dense ivory-like ossification of the ossicone of Major Cotton's specimen (Plate VII.).

The relative age of this Okapi is shown by the fact that the deciduous molars are all shed and the premolars moderately worn, whilst the molars are all “through” and moderately worn.

the larger and older ossicone, whilst less spongy than that of the smaller and younger one.]

#### EXPLANATION OF THE PLATES.

##### PLATE VI.

Figs. 1 to 8 represent various views of the “horn-tips” of the ossicones or ossicuspis of the Okapi in the Royal Scottish Museum, Edinburgh, of the natural size (Specimen A).

Figs. 1, 4, 5, and 7 are views of the left horn-tip.

Figs. 2, 3, 6, and 8 are views of the right horn-tip.

Fig. 1. Left ossicone, outer side; *y*, depression due to shedding of a piece of the bone.

2. Right ossicone, inner (mediad) side; *x*, cup-like cavity due to shedding of a portion of the bone.

3. Right ossicone, outer side.

4. Left ossicone, inner (mediad) side; *y* as in fig. 1.

5. Left ossicone, from behind and below.

6. Right ossicone, from behind and below.

7. Left ossicone, from in front and above.

8. Right ossicone, from in front and above: *x* as in fig. 2.

Figs. 9 to 12 represent two views of the “horn-tips” of the ossicones of a specimen of Okapi lent by Messrs. Rowland Ward and now in America (Specimen B).

Fig. 9. Left ossicone, outer side.

10. Right ossicone, outer side.

11. Left ossicone, from in front and above.

12. Right ossicone, from in front and above.

## PLATE VII.

The figures illustrate the ossicone of the right side of Major Powell Cotton's male Okapi.

- Fig. 1. The specimen of the natural size, seen from the right.  
 2. The base of the ossicone, held by soft tissue to a similarly madreporic-like surface of the frontal bone. Natural size.  
 3. Surface of the horn-tip, left side, enlarged to twice the natural size to show the absence of polishing and of transverse fissures. The ossicone was completely covered by integument; it had not been "cut" or emerged.  
 4. Similar view of the right side.  
 5. Similar view of the horn-tip from in front.  
 6. Similar view from behind.  
 7. The horn-tip has been sawn through so as to remove the right-hand moiety of the tip. The extremely dense, ivory-like character of the bone of this region is thus demonstrated, and the absence of horizontal or other penetrating fissures (compare and contrast with the text-figures, especially text-fig. 52).

4. Description of *Hyla resinificatrix* Goeldi, a new Amazonian Tree-Frog peculiar for its Breeding-habits. By Prof. Dr. EMIL A. GOELDI, C.M.Z.S., Director of the Pará Museum.

[Received January 21, 1907.]

(Text-figures 56-59.)

In its warty skin this remarkably fine Tree-Frog resembles *Hyla tuberculosa* Günther, *Hyla taurina* Steindachner, and *Hyla venulosa* Laur. It is most closely related to the last.

Length of a male, 8 cm. from snout to vent.

Head semicircular. Space between the two nostrils slightly concave. Nasal region descending abruptly to the border of the mouth, almost at right angles to the frontal plane. Canthus rostralis running in a curve, rounded off. Nostrils, seen from above, forming slight prominences. Choanæ large. Vomerine teeth in two rows, forming an angle pointing forwards. Tongue heart-shaped.

Tympanum very distinct, moderate sized, rather smaller than the eye. In the male distinctly prominent vocal sacs between the rictus of the mouth and the insertion of fore-legs.

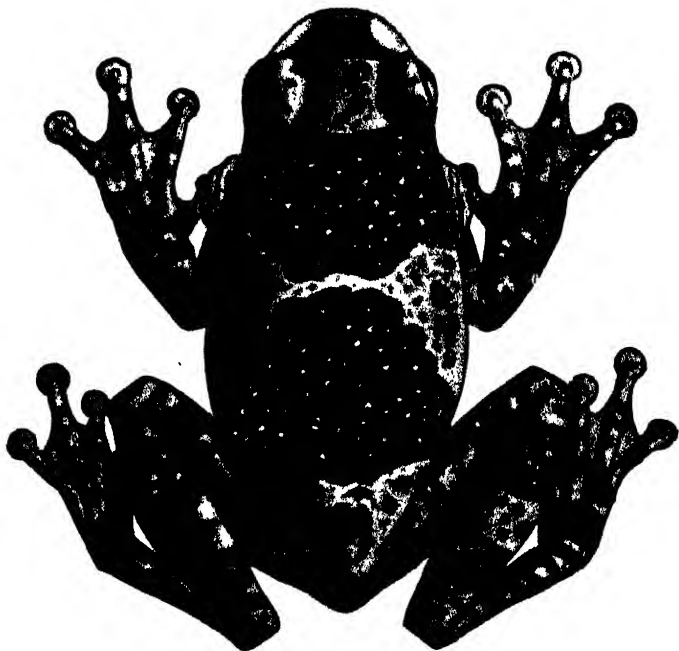
Fingers III, IV, and V connected about half their length by a web; no perceptible rudiment of thumb. Finger-disks large, a little smaller than the tympanum. Outer border of arms without folds of the skin. When the hind legs are stretched forward, the tibio-tarsal articulation reaches the eye or the border of the mouth. Heels without appendage.

Tubercles of sole of foot not so prominent as in *Hyla taurina*.

Colour greenish-yellow with blackish-brown markings: a brown trapeze-shaped field between nose and anterior border of eyes; a light-coloured, broad band running from one eye to the other, the width of the eye, anterior bordering line straight, posterior line slightly curved backwards; a large dark field covering all the dorsal region, laterally running down to the insertion of the fore

legs, posteriorly leaving in the sacral region a triangular light-coloured space. Between the insertion of the hind legs, situated in the median line, there may be a small dark ring with a central dark point (text-fig. 57 A). Dorsal area either entire or laterally constricted about the middle (as in a fourth specimen not figured), or divided in two isolated parts by a light-coloured cross-band (text-figs. 56 and 57 B). The dark dorsal blotches are thickly studded with thorn-like elevations (pointed warts) with a light-coloured apex (text-fig. 56), more thickly agglomerated in the

Text-fig. 56.

*Hyla resinifictrix*, male (nat. size).

parotoid region (left side 13, right side 22, in one individual, and also in the posterior part 22 + 24 in one individual), besides an abundance of smaller elevations and diminutive granulations. A brown band around the upper arm, another around the forearm, very well pronounced (with some lightish spots, imitating the light central wart-spots of the back, but not raised); across the hand several narrower bands. Legs: thigh with two bands; lower leg with two broader bands, with the same whitish spots as above mentioned; across the ankle and foot several narrower bands.

Forehead with some dark, roundish spots.

Upper border of mouth dark-marbled.

Ventral surface light greenish-yellow, granulated and turning warty about the chest. Upper-arm band on the anterior side with two or three light spots; some light yellow elongated spots at the anterior border of the vocal sacs. Border of lower lip as well as the finger-disks of a delicate green.

From a side view with the extremities folded, on the anterior extremity the dark bands on upper and lower arms appear to be continuous with the posterior border of the anterior large dark dorsal field; just as in the posterior extremity the dark bands nearest to the knee (femoro-tibial articulation) coincide with the posterior border of the second large dorsal field, while the bands nearest the heel (tibio-tarsal) coincide with the round sacral spot (text-fig. 57 A), the central spot forming with the lateral bands and dots a fan-like arrangement (confer also text-fig. 57 B).

Text-fig. 57.



A.

B.

*Hyla resinifictrix* (diagrammatic).

Comparison of the four specimens available shows a considerable extent of individual variation in the details of ornamentation. However, it is easily seen that certain general features persist fairly well, the most salient among them certainly being the broad light transverse band on the head, running from one eye to the other.

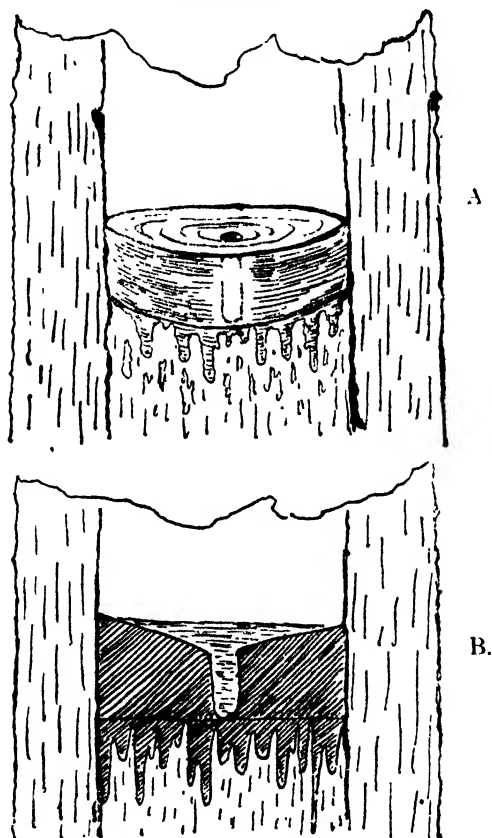
The iris is golden, with a horizontal and a vertical black bar, forming a cross\*.

This large and strikingly coloured Tree-Frog presents a most curious novelty in its breeding-habits. Some years ago Mr. Boulenger, of the British Museum, published in an interesting

\* As described in *H. venulosa* by Boulenger, Ann. & Mag. N. H. ser. 5, vol. x. p. 327 (1882).

article a tabular synopsis showing the different incubation-habits among the Batrachia. In this synopsis a unique position is held by the tree-frog *Hyla palmata*, which, according to observations made by me in the Serra dos Orgãos (Rio de Janeiro), and published in the 'Proceedings' of the Zoological Society, 1895, forms breeding-bowls of the mud in shallow ponds.

Text-fig. 58.



Breeding-basin of *Hyla resinifictrix*, (A) side view and (B) section (diagrammatic).

A still more peculiar eccentricity is presented by this beautiful new Amazonian tree-frog, *Hyla resinifictrix*. Inhabiting the virgin forest, it chooses certain tall trees for its dwelling, where it takes possession of a hollow branch (text-fig. 58, A and B), and constructs there as a nursery a good-sized basin of resinous substances, with a central depression (text-fig. 59). As is well known,

water and other liquids are preserved fresh in vessels varnished with pitch, and in like manner the rain-water which fills these resinous breeding-bowls presents excellent conditions for the hatching and development of the eggs and tadpoles, such as shade and freshness of water without contamination of decayed wood. Without having had as yet the good fortune to verify it by direct observation, I have abundant reason to suppose that the development stage of the tadpoles is exceedingly brief, analogous with the case of *Hyla goeldii* Boulenger in the Serra dos Orgãos, *Hyla venulosa* in Pará, and others.

Text-fig. 59.



Breeding-basin of *Hyla resinificatrix*, seen from above (from a photograph).

One very interesting feature is the fact that this Amazonian tree-frog goes in search of the material with which to build the basin, and chooses for the purpose odorous resins which drop from the bark of certain trees, such as the aromatic "breo-branco" (*Protium heptaphyllum*) and others.

Although the resin of the "cunnuarú" is well-known to the Indians and mixed races in the Amazonian valley, constituting a commodity much sought for and of high price, the tree-frog itself was entirely unknown to all except the genuine forest-dwelling Indians. In spite of strenuous efforts it took me more than ten years to get on the track of this most mysterious Batrachian, and if finally my efforts were crowned with success, it was largely due to the friendly aid of the Tembé Indians at the Mission of Santo Antonio do Prata, at the River Maracanã (interior of the State of Pará), by the kind interest of Frei Daniel de



Samarate, Director of the Mission. With their help I succeeded in obtaining several individuals, one of which (♂) at least is still alive after spending nearly two years in a terrarium properly fitted up for it. Last year it gave me frequent opportunities to hear its voice, which is surprisingly strong, and sounds as "queng-queng" three or four times repeated.

The local name "cunuarú," evidently onomatopœic, is formed by contraction of two Indian words "cunhã = wife" and "arú = toad"; the Indians say that this tree-frog always calls for the female when the moon shines.

5. The Duke of Bedford's Zoological Exploration in Eastern Asia.—III. On Mammals obtained by Mr. M. P. Anderson in the Philippine Islands. By OLDFIELD THOMAS, F.R.S., F.Z.S.\*

[Received February 5, 1907.]

In the early part of last year, after making the Korean Collection described in a previous volume of our Proceedings†, Mr. Malcolm Anderson paid a short visit to the Philippines, but was unfortunately attacked by fever, and after a gallant attempt to fulfil the object of his trip, was compelled to return to more northern and healthier latitudes.

The chief object of Mr. Anderson's visit to the Philippines was to obtain series of the interesting mammals discovered in Mindanao by Dr. E. A. Mearns‡, as the mountain fauna of this island was only represented in our National Museum by the duplicates from Dr. Mearns's collection which the authorities of the United States National Museum had been good enough to send us. But these of course did not include any of the various new genera and species which had been described by Dr. Mearns on single specimens or on small series, and we therefore hoped that Mr. Anderson might be able to obtain some of them for us.

Owing to Mr. Anderson's illness the collection is quite small, only consisting of 16 specimens belonging to 6 species, but one of these proves to be new, while all are of interest as filling up gaps in our series.

1. *UROGALE CYLINDRURA* Mearns.

♂. 756, 763. ♀. 753, 761, 762. Mount Apo, Mindanao, 3000'-4000'.

I am very doubtful if this form is at most more than a local subspecies of *U. everetti*§, described from Zamboanga. The type of the latter had been skinned after preservation in spirit, and such slight colour differences as there are may be due to this cause.

\* [The complete account of the new species described in this communication appears here; but since the name and preliminary diagnosis were published in the 'Abstract,' the species is distinguished by the name being underlined.—EDITOR.]

† P. Z. S. 1906, p. 858.

‡ See Mearns, P. U.S. Nat. Mus. xxviii. p. 425, 1905.

§ *Tupaia everetti* Thos. Ann. Mag. N. H. ser. 6, ix. p. 250, 1892.

2. *SCIURUS MINDANENSIS* Steere.

♂. 764. Mount Apo, Mindanao. 3000'.

3. *MUS* sp.

♀. 748, 750. North Central Mindanao. 1100', 3000'.

♀. 754. Mount Apo, Mindanao. 3000'.

A rat of the *rattus* group. Dr. Mearns describes no less than three species of this group, but does not seem to be aware that the presence of spines in the fur in these rats is a most variable character, depending in all on age, and in some on season, the spines being shed and regrown periodically.

4. *MUS BAGOBUS* Mearns.

*Bullimus* (g. n.) *bagobus* Mearns, P. U.S. N. M. xxviii, p. 450, 1905.

♀. 755. Mount Apo, Mindanao. 3000'.

I fail to see any sufficient reason for the creation of a special genus to contain this species. The small supplementary cusps on the lower molars, on which Dr. Mearns mainly founds the genus, are not only present in many Malayan species usually referred to *Mus*, but they are even quite well-marked, though small, in his own specimens of *Mus albigularis* Mearns, also from Mindanao. None of the other characters mentioned by him appears to me of generic importance.

It is unfortunate that Dr. Mearns had not had experience of the difficulties of Murine dental characters before venturing to describe genera of this group. Had he had such experience I am sure he would not have described *Bullimus*, nor would he have based another genus (*Limnomys*) on a single specimen with teeth "too worn to furnish characters distinguishing them from *Mus*," unless the other characters were of a far more striking nature than appears from his account.

Mr. Anderson's specimen of *Mus bagobus*, being a female, enables me to state that the mammae number  $1 - 3 = 8$ , a formula only occurring to my knowledge in two other Eastern species of *Mus*.

5. *MUS VULCANI* Mearns.

♀. 752. North Central Mindanao. 4000'.

A member of the common and widely spread *concolor-ephippium* group.

6. *CRUNOMYS MELANIUS* Thos.

Abstr. P. Z. S. 1907, p. 5 (Feb. 12).

♂. 751. North Central Mindanao. 3000'. 29 February, 1906. B.M. No. 7.2.2.14. *Type*.

A species with the general appearance of a blackish *Akodon* of

the *A. caliginosus* group, or perhaps more of a member of the subgenus *Melanomys*.

Size rather larger than in *C. fallax* of Luzon. Fur close and fine, but rather stiff owing to the admixture of a number of fine flattened spines; hairs of back about 6-7 mm. in length. General colour above blackish brown, nearest to bistre of Ridgway but darker; the under surface nearly as dark as the upper, without any line of demarcation. Individually the hairs of the back are dull slaty basally, with buffy tips; the spines slaty with black tips. Ears very short, closely haired, brown. Whole of limbs, including hands and feet, blackish brown. Tail short, very finely scaled (scales about 18 to the centimetre), finely haired, the hairs about  $1\frac{1}{2}$  scales long; uniformly blackish throughout.

Skull less flattened than that of *C. fallax*, but this may be due to youth. The brain-case long, comparatively parallel-sided, in continuation of the broad interorbital region. Supraorbital edges with scarcely a trace of beading. Outer plate of zygoma-root cut back just as in *C. fallax*. Palatal foramina short, narrow in front, broadened behind, not parallel-sided as in *fallax*.

Molars rather like those of a very simple type of *Mus*, without any supernumerary lateral cusps.  $M_1$  and  $M_2$  each with a small median posterior cusp as in *C. fallax*.

Dimensions of the type, which is barely adult:—

Head and body 98 mm.; tail 68; hind foot (s.u.) 25; ear 13.

Skull—greatest length 28 mm.; basilar length 22; zygomatic breadth 14; length of nasals 9.2; interorbital breadth 5.6; breadth of brain-case 12.3; palatilar length 11; diastema 7; palatal foramina  $3.8 \times 2.2$ ; length of upper molar series 4.1.

*Hab.* and *Type* as above.

The characters of this remarkable species are a great puzzle, and only add to the difficulty of assigning a proper position to the type of the genus, *Crunomys fallax*. The single specimen of the latter is very old, and in the worn-down state of the teeth it was not clear whether they were or were not of hydromyine structure. The teeth of the present animal are certainly not typically hydromyine, but rather murine, while at the same time it is possible that in wearing down they might acquire the slight resemblance to hydromyine teeth shown by *C. fallax*. This being the case, I have decided to describe the species, though with doubt, as a *Crunomys*, but until younger specimens of *C. fallax*, or older ones of the present form, are available for examination, it would be advisable not to express any definite opinions as to the systematic position of either. As a species *C. melaninus* is at once distinguishable by its blackish colour and heavier feet.

7. *Sus* sp.

4 skulls. Mount Apo, Mindanao.





J. Green photo imp.

BLOTCHED TABBY, FELIS CATUS.



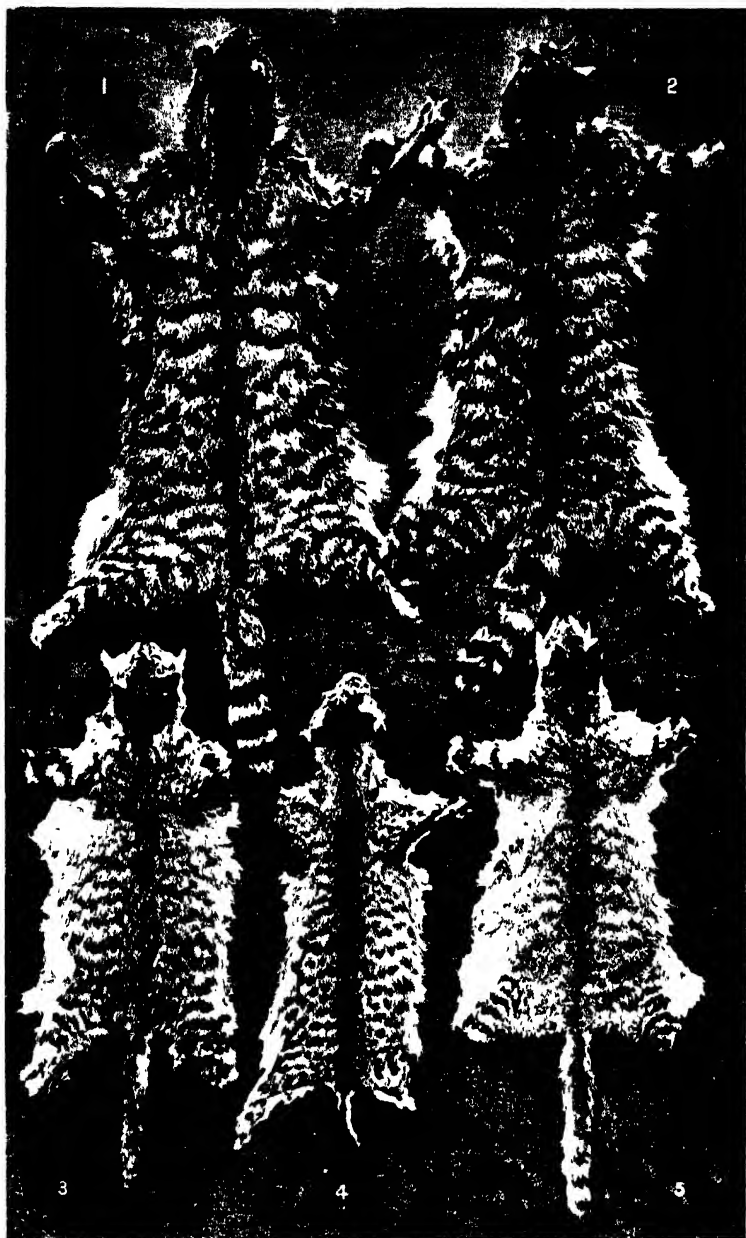


J Green photo Imp

STRIPED TABBY, FELIS TORQUATA.







J. Green photo imp.

AGRIOTYPES OF THE STRIPED TABBY.





February 19, 1907.

Sir EDMUND G. LODER, Bt., Vice-President, in the Chair.

The Secretary read the following report on the additions that had been made to the Society's Menagerie in January 1907:—

The registered additions to the Society's Menagerie during the month of January were 108 in number. Of these 55 were acquired by presentation and 11 by purchase, 41 were received on deposit, and 1 was born in the Gardens. The total number of departures during the same period, by death and removals, was 163.

Amongst the additions special attention may be directed to:—

An Agile Gibbon (*Hylobates agilis*) from Borneo, purchased on Jan. 17th.

A Wild Cat (*Felis catus*) from Inverness-shire, presented by Mr. G. W. Henderson, F.Z.S., on Jan. 26th.

Two Superb Tanagers (*Talliste fastuosa*), a Crowned Tanager (*Tachyphonus coronatus*), and two Scarlet Tanagers (*Rhamphocelus brasilius*), from Brazil, purchased on Jan. 21st.

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Dr. C. I. Forsyth Major, F.Z.S., exhibited remains of a Bear from the superficial deposits of a cavern in the mountains of Corsica, where Bears, though now extinct, were formerly numerous, at least up to the sixteenth century. Despite the fact that no truly fossil Bears were as yet known from Corsica, Dr. Forsyth Major considered the Corsican Bear to have been autochthonous, whilst in his opinion the recent Mammals of Corsica (and Sardinia) had been, almost without exception, introduced by human agency. In any case they could not be adduced as proofs of a recent connection of those islands with either of the neighbouring continents.

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The following papers were read:—

1. On English Domestic Cats. By R. I. Pocock, F.L.S., F.Z.S., Superintendent of the Zoological Society's Gardens.

[Received February 5, 1907.]

(Plates VIII.-X.\* and Text-figure 60.)

### 1. *The Classification of English Domestic Cats.*

Domestic Cats in Great Britain are classified by the National Cat Club under two headings:—(1) Short-haired; (2) Long-haired, otherwise called "Persians" or "Angoras." The "Persians" are subdivided according to colour into "Blacks,"

\* For explanation of the Plates, see pp. 167, 168.

"Smokes," "Sables," "Blues," "Oranges," "Creams," "Whites," "Tabbies," "Tortoise-shells," &c. The "Short-haired" are similarly distinguished, after the elimination of certain types like "Siamese," "Manx," and "Abyssinians," to which special classes are assigned\*.

From the exhibitors' and breeders' points of view this arrangement has much to recommend it, and probably supplies the most feasible and satisfactory method of classifying the various breeds that are set side by side for comparison. The animals must be sorted out upon some basis, and it would perhaps be impossible to suggest a substitute that would meet the requirements of fanciers equally well.

But, from the standpoint of affinity and descent, I think it is open to the criticism that a primary importance is given to characters like the length and thickness of the fur, the tint of the ground-colour, and the absence of the tail, which can be shown to have no great systematic value; whereas a quite subsidiary significance is attached to the nature of the pattern of the stripes, a character which should be of the greatest moment in differentiating the breeds, if confidence be placed in the analogy supplied by existing species of the genus *Felis*.

It may fairly be asked, however, why a greater taxonomic value is claimed for the "pattern" than for the three characteristics mentioned above upon which fanciers establish their breeds. The answers are briefly these:--

1. The shortness of the hair in tropical Leopards and Tigers as compared with those that come from colder countries shows that no great systematic importance can be attached to length of coat. The difference between the extremes of long- and short-haired Domestic Cats is admittedly much greater than that between long- and short-haired Leopards or Tigers: but all gradations between "Persian" and ordinary Cats exist, so that no hard-and-fast line can be drawn between them; and probably no one doubts that the luxuriant growth characteristic of the former breed has been preserved and increased by artificial selection. In the matter of coat, the adaptability of Domestic Cats to changed conditions is proved by the evolution of a thick-haired breed in the Pittsburgh refrigerators † and in the arctic island of St. Paul ‡, and by the alleged shortness and stiffness of the fur in Domestic Cats from Mombasa in East Africa §.

2. The conclusion that the shortness or complete absence of the tail in so-called "Manx Cats" has been brought about by selective breeding from favoured sports must be regarded as beyond dispute. There is no such thing as a tailless species of *Felis* amongst fossil or recent forms. The tail is short in Lynxes, but

\* 'Cats and all about them,' 1902; and 'The Book of the Cat,' 1903, by Frances Simpson.

† Quoted from Lydekker, 'Cats, &c.' p. 159 (1896) (Allen's Nat. Library).

‡ See H. C. Marsh, 'Darwinism,' p. 21 (1883).

§ Darwin, 'Animals and Plants under Domestication,' p. 58 (ed. 1905).

it cannot be claimed that an intermixture with any known species of *Lynx* has contributed to the abbreviation of the tail in the "Manx." When and where this breed arose has been much debated. Some have suggested Spain as its original country, others China. But in all probability the "sport" has appeared independently and been preserved by selective crossing on many occasions and in many places.

The liability of the tail to modification in Domestic Cats is shown by the frequency with which it is kinked or twisted as well as shortened in Burmese, Siamese, and Malaccan specimens; and by the stunting it acquired in a few generations in the Cats, above alluded to, that were bred in the frigid climate of St. Paul's Island and in the cold-storage warehouses of Pittsburgh.

3. With respect to tint or the ground-colour as a whole, irrespective of pattern, it must be remembered that albinotic and melanotic "sports" may arise in almost any group of Mammals. Amongst the Cats, albinos appear to be rare in a state of nature, probably in part on account of a correlated inherent delicacy in organisation, accompanied possibly by defective sight or hearing; probably in part on account of the conspicuousness of the coloration making capture of prey and escape from enemies, especially during cubhood, difficult. There are one or two records, however, of albino Tigers—the species, be it noted, in which the young after leaving the mother's protection are more capable of taking care of themselves and less liable to attack than any other Cat, with the possible exception of Lions. Melanisms are far more frequently met with in the genus. Black Leopards are familiar to all; black Jaguars are not uncommon, and black Tigers, Caffre Cats, and Servals have been recorded.

In other species the tint may be dimorphic, dark grey or dark brown and red or chestnut examples being about equally abundant, as in the S. American *Felis jaguarondi*, the West African *Felis aurata*, the Oriental *F. temmincki*, and the Bornean *F. badia*.

Thus in the genus *Felis* colour-variation in a state of nature may depart from the normal in the direction of "black," or "red," or "white," without respect to locality. Moreover, geographical variation also attesting inherent instability of tint is met with. The greyness of the Persian Leopard as compared with the rich tawny yellow of South Indian specimens is a case in point.

The tints of Domestic Cats themselves establish the same conclusion. Between "blacks" and "whites" all intermediates seem to exist. "Blues" are self-coloured slate or lavender-grey cats and appear to be merely stages in the direction of "blacks." "Smokes" are darkish grey or blackish cats with the basal part of the hair white. "Silvers" are the "palest conceivable edition" of Smokes. "Reds," "Yellows," and "Creams" are variations from the normal in the direction of "Whites."

4. On the other hand, notwithstanding individual and local variations, the pattern formed by spots or stripes in existing

species of *Felis* is on the whole constant. Stripes may break up into spots or spots may run together to form stripes, or both spots and stripes may be altogether fugitive. Yet even in extreme and rare cases of this nature, the general "character" of the pattern, when detectable, remains the same, and there is abundance of evidence that the animals breed true to the local type. *Nor, so far as I am aware, is there any reason to suppose that dimorphism in pattern ever occurs or has ever occurred in any species of the genus Felis.*

It is needless to say more in support of the contention that if a decided difference in the "patterns" of Domestic Cats exists, it must be regarded as furnishing a surer basis for their classification than the length of the hair, the tint of the coat, or the stunting of the tail.

It may also be claimed with assurance that the pattern supplies a more important clue to the ancestry of Domestic Cats than the features just mentioned.

Probably no one will dispute that all breeds of Domestic Cats have been derived from one or more than one ancestral type that was marked with bands or spots. This opinion is supported by two considerations. The first is this: spotting or banding of one type or another characterises the great majority of the existing species of Cats, using this term in its broad sense as co-extensive with the genus *Felis*\*. A few self-coloured Cats, like Lions, Pumas, Caracals, and others, exist; but their descent from striped or spotted forms is attested in most cases by the presence on the cubs† of markings which are subsequently lost or by indications of them, especially on the legs or lower parts of the body, in the adults.

The second pertinent point is the prevalence of stripes forming a pattern of one kind or another, both in "Persians," "Short-haired," and "Manx" breeds, and the difficulty breeders experience in eradicating these markings in their efforts to preserve a particular self-coloured type. Frequently at all events the so-called "blotched" pattern can be detected in certain lights even in "Whites" and "Blacks," the two varieties which stand at the extremes of the colour-mutations of the diverse domestic breeds.

Assuming, then, that domestic breeds are descended from one or more than one striped or spotted species, we may safely set aside the self-coloured forms as derivatives and consider only the striped or spotted types in looking for the origin and for a reliable basis for the classification of Domestic Cats.

Domestic Cats in which the markings on the skin form definite patterns are called comprehensively "Tabbies." Of "Tabby" Cats, as fanciers well know, there are two kinds, the "striped" and the "blotched." These are not, however, regarded as different

\* I purposely ignore here the subgeneric divisions of *Felis* adopted in Trouessart's 'Catalogue of Mammalia,' because I cannot admit that these connote, at least in all cases, natural assemblages of species.

† Young Caracals are not spotted or striped, but resemble their parents.

breeds. Nevertheless the patterns appear to be fundamentally distinct from each other in the sense that the differences between them are not differences of degree, but of kind. Without assuming the existence in the past of a number of intermediate stages which do not appear to exist in the present, it is impossible to reduce them to a common plan and it is difficult to see how one can have arisen from the other unless *per saltum*\*.

One or the other of these patterns, when the pattern is traceable at all, may be seen in Cats of the short-haired, long-haired, or Manx breeds, whether the ground-colour be grey or red, or black or white, or any other tint. Neither at Cats' Homes nor at Cat Shows nor in the streets have I seen one cat out of the hundreds observed in which the pattern could not be assigned at once to one or the other of these types. Here, then, is evidence for the existence, side by side, of two fundamentally distinct kinds of "Domestic Cats." These I propose to regard as species, trusting to the analogy supplied by wild forms of the genus *Felis* and knowing no reason for thinking, much less proof of the fact, that one has been derived from the other, either as a sudden sport or by gradual modifications under the influence of selective breeding or by inter-breeding with any wild species of the genus.

The two types are described in some detail below (see pp. 151-153). They may be very briefly diagnosed as follows:—

- a. Sides of the body, from the shoulder to the root of the tail, marked with narrow wavy vertical stripes which show a tendency, especially on the thighs, to break up into spots; no broad latero-dorsal stripe ..... *Striped "Tabby."*
- b. Sides of the body marked with three usually obliquely longitudinal stripes forming the so-called "spiral," "horseshoe," or "circular" pattern of fanciers; a broad latero-dorsal stripe on each side of the narrow median spinal stripe ..... *Blotched "Tabby."*

It is difficult to ascertain from the writings of earlier naturalists whether they were familiar with these two types of Cats or not. There is certain evidence that the blotched or true "Tabby" Cat was domesticated in Sweden and known to Linnæus as early as 1746. And that the Striped Cat was also domesticated in Europe at a still earlier date is proved, I think, beyond doubt by the figures published in Gesner's *Hist. Anim.* p. 345 (1551), and in Johnston's 'Quadrupeds,' pl. lxxii. p. 126 (1657). If these and later post-Linnean authors distinguished the two Cats, it must be inferred that they attached no significance to the difference of pattern, but regarded it as of the same value as the difference of colour and as the asymmetrical blotching of piebald specimens. Pennant, for example, speaking of the Tame Cat, says that it

\* The differences between these two types are described and figured by Mr. T. S. Rope ('Zoologist,' 1881, pp. 359-367). Perhaps the omission of this paper from the 'Zoological Record' may explain in part the want of consideration the facts have received from most recent zoological writers on this subject.



differs only "in color and some other trifling accidents" from the Wild Cat (British Zoology, vol. i. p. 94, 1812), and Kerr describes the stripes on the sides of the Wild Cat as being "perpendicular or spiral" (Anim. Kingd. p. 152, 1792), thinking apparently that the blotched "Tabby" was a domesticated form of the European Wild Cat and that the shape and direction of the stripes were subject to variation and of no particular moment.

Even the writings of later authors leave them open to suspicion on this point. Gray, for example, pointed out that a Domestic Cat brought by Darwin from S. America was remarkable for its striking likeness to the Caffre Cat. But there is nothing surprising in this if, as I suppose from the description, the Cat in question was merely a slightly aberrant example of the Striped "Tabby" breed. This Gray could hardly have failed to detect had he been familiar with the Domestic Cats of London. Again, since Blanford and Mivart both regarded Indian specimens of the "Striped breed," known as *F. torquata*, as examples of a genuine wild species, it may be inferred that they were both ignorant of the fact that Cats inseparable from that type, as figured by Cuvier, might be seen any day in London, where and at the time when their volumes, below (p. 159, footnote) cited, were being written.

Setting aside breeders and owners of "Fancy Cats," who could hardly be expected to appreciate the significance of the differences of pattern above described, although well aware of their existence, two scientific writers on Cats must be mentioned as clearly apprehending the fact. One of these is Rope, whose paper, published in 1881, has been already mentioned; the other is that astute observer Blyth, who so long ago as 1845\* pointed out that the two types of pattern are found in the Domestic Cats of Europe. In an additional note on the subject published in 1856†, he spoke of the true Tabby pattern as being possibly a "modification (and a very remarkable one) of the markings of the wild *F. sylvestris* of Europe."

Rope apparently did not know of Blyth's papers. All the more remarkable is it therefore that both authors describe this Tabby as being marked with pale streaks on a dark ground; and this description was repeated by Hamilton in his notice of Rope's paper. It is obvious, however, that no Cat can be scientifically described as marked in this way. Hence it is possible that the misleading terminology employed by Blyth, Rope, and Hamilton may have suggested to the readers of their writings that the blotched "Tabby" markings belong to the same category as the piebald or skewbald, usually asymmetrical coloration of black-and-white or brown-and-white cats, dogs, horses, cattle, and other tamed or domestic mammals infected with either melanism, albinism, or erythrism, or with any two of these taints, or with the three combined. This may partly account for the fact that the difficulty of deriving the blotched Tabby pattern from that of *F. ocreata* or

\* Journ. As. Soc. Bengal, xiv. pt. i. pp. 342-343.

† Op. cit. xxv. p. 443.

*F. sylvestris*, and of accounting for the origin of the breed, seems never to have been fully realised, or, if realised, never seriously faced. And doubtless a contributory cause to this result has been the artificial character of the classification of Domestic Cats adopted by fanciers, which gives emphasis to valueless features and obscures the fundamental importance of the pattern.

## 2. *On the Characters and Names of the Two Types of Domestic Cat and the Name of the European Wild Cat.*

In the foregoing and following pages the European Wild Cat is referred to as *Felis sylvestris*. This requires explanation, since the species in question has, by almost common consent, been hitherto called *Felis catus*.

In my opinion there is no possibility of evading the conclusion that the Cat to which Linnaeus gave the name *catus* was not the European Wild Cat, but the Domestic Cat of the blotched Tabby kind. In the 10th edition of the 'Systema,' 1758, accepted as the starting-point in zoological nomenclature, *Felis catus* is characterised in such terms as to leave no room for doubt on this head. In the first place, there is a back reference to the 'Fauna Suecica,' 1746, where of *Felis catus* it is said "*habitat in domibus; cicurata: exoticae originis.*" In the second place, the diagnosis in the 'Systema' runs as follows:—" *Felis caudata, elongata; corpore fasciis nigricantibus; dorsalibus longitudinalibus tribus; laterali-bus spirali-bus.*" The spiral lateral stripes are obviously those that form the so-called "circle" or "horseshoe" characteristic of the blotched "Tabby"; and the three dorsal longitudinal stripes are also typical of that animal. This description is totally inapplicable to the European Wild Cat, which moreover does not occur in Scandinavia, and was apparently unknown to Linnaeus, except from books. It is equally inapplicable to the "Striped" race of Domestic Cats. On the other hand, it exactly fits the blotched Tabby Domestic Cat, and was quite likely taken from a specimen lying on Linnaeus's hearthrug at the time.

There is no doubt from the context and the bibliography in the 10th ed. of the 'Systema' that Linnaeus believed this Cat and the European Wild Cat to be the same species of animal; but that error does not in any way affect the certainty of the conclusion that he knew only the domestic blotched "Tabby" and described it as *catus*.

The name "*domestica*" must, I think, be discarded as a synonym of *catus*, since both Schreber and Erxleben, the two earliest post-Linnaean authors to use that term, quote under the heading *domestica* Linnaeus's diagnosis of *catus*. And since all the so-called Tortoise-shell Cats that I have seen belong to this type, the name *hispanica* Erxl. may also be placed amongst the synonyms of *catus*; *vulgaris* Fischer is also a synonym.

The name "*catus*," then, is no longer admissible for the European Wild Cat. For this species there are two names

available, which were apparently published in the same year; and between these a choice has to be made. These are:—

*ferus* Erxleben, Syst. Regni Anim. i. pp. 518 & 522 (1777).  
*sylvestris* Schreber, Säug. iii. p. 397 (1777), pl. cvii. A. (date ?)\*.

The synonymy of *Felis catus ferus* published by Erxleben shows that he followed Linnæus in regarding the European Wild Cat as what may be called the "agriotype" of the various domestic breeds, such as *domestica*, *angorensis*, *hispanica*, and *cærulea*, described on pp. 520-522; and the excellent diagnosis of the Wild Cat published on p. 522 beginning *Catus Ferus major*, proves that he was acquainted with that species, and applied the name *ferus* to it, and not to feral examples of a domestic breed.

But for the following reasons I think *sylvestris* should be preferred:—(1) Schreber adopted this name from Brisson's Regn. Anim., Quadr. p. 265, which, being published in 1756, is pre-Linnæan so far as nomenclature is concerned. Nevertheless, the diagnosis of *F. sylvestris* suggests that Brisson distinguished this Cat from the domestic *catus* of Linnæus. (2) Erxleben quotes both Brisson's and Schreber's works in his bibliographical synonymy of *F. catus ferus*. Of Schreber's work he correctly cites pl. cvii. A. inscribed *Felis Catus* Linn. *ferus*. Hence I infer that he saw or knew by hearsay of this plate. I cannot, however, find proof that it was published, properly speaking, before the issue of the text in 1777. Since, therefore, the name *sylvestris* in the text has page priority over the name *ferus* on the plate, preference should be given to the former and the latter regarded as a synonym. (3) The name *sylvestris* has been used for this Cat by some modern writers, notably by Blyth and Hamilton.

For these reasons I think it advisable to adopt *sylvestris* instead of *ferus* as the specific name for the European Wild Cat.

Apart from the convenience of having a name for a Cat which not uncommonly occurs feral in the tropics, the determination of the correct name for the "Striped" Domestic Cat is a matter of no great moment. Moreover, it is practically impossible to settle with certainty which name should be chosen out of the many given by earlier writers to various domestic breeds in different parts of the world†. In addition to *domestica* and *hispanica*, already referred to, the following are the most important:—*cærulea* Erxl. for the "Blue Cat," which seems to be a pale or incompletely melanistic sport perhaps of the striped, perhaps of the blotched type; *angorensis* Gmel., for the long-haired breeds, which were no doubt originally of the "Striped" type; *ruber* id., for a red variety with a dark dorsal stripe; *sinensis* Kerr, for a Chinese race alleged to have pendulous ears;

\* For discussion of the dates relating to Schreber's work see Mr. C. D. Sherborn's paper, P. Z. S. 1891, pp. 588-589.

† These names have to be catalogued to prevent their inadmissible use in a different sense by later writers (see Sherborn, Index Anim. p. 187, 1902).

*aureus* id. (= *longiceps* Bechst.), for a yellowish, short-legged, long-headed, sharp-nosed breed, said to inhabit New Spain; *madagascarensis* id., for a Madagascar Cat with a twisted tail; *striata* Bechst., for a black-striped "Cyprian" Cat, which is diagnosed as follows:—"Mit schwarzen Streifen auf hellem Grunde, die auf dem Rücken gerade, auf den Schenkeln aber gekrümmt sind" (Bechstein, Pennant's 'Uebersicht, etc.' ii. p. 679, 1800). In a general way this description applies to both types of Cats under discussion, and perhaps on the whole more closely to the "blotched" than to the "striped" breed. But if the "Cyprus" Cat came originally from Cyprus, a conclusion by no means justified by the epithet, it belonged in all probability, as did the Angora Cat, to the "Striped" and not to the "Blotched" type\*.

But whatever opinion may be held with regard to *angorensis* and *striata*, there is no doubt that examples of this Cat, whether feral or not, furnished types for the following forms:—

*F. torquata* F. Cuvier, Hist. Nat. Mamm. pl. 126 (1826), recorded from Nepaul, Bengal, &c. (see *infra*, p. 165).

*F. inconspicua* Gray, Charlesworth's Mag. N. H. p. 577 (1836).

*F. huttoni* Blyth, J. A. S. B. xv. p. 169 (1846), xvii. p. 247, xxii. p. 581, from Candahar.

*F. ocreata agria* Bate, P. Z. S. 1906, p. 317, from Khania in Crete.

The figure of *F. torquata* and the description of *F. huttoni* leave no room for doubting the identity of the Cats; and the types of *inconspicua* and *ocreatea agria* are in the British Museum and have been compared by me with English examples of Striped Cats.

This type (*torquata*) may be described as follows:—Ground-colour typically iron-grey or yellow-grey. The four cephalic and cervical stripes sometimes distinct, sometimes indistinct. The ad-median cervical stripes not abbreviated on the anterior area of the nape; the external cervical stripes not diverging from the middle line on its posterior area. Dorsal area of body from the shoulders to the root of the tail darker than the sides, the pigment often resolvable into three narrow, almost contiguous stripes, two laterals more or less interrupted, and a more complete median which is usually continued down the middle line of the tail. On the summit of the shoulder the lateral stripes are frequently thicker and more heavily pigmented than they are posteriorly. From the dark dorsal area on to the belly pass a number of vertical wavy transverse stripes, which are usually more distinct on the thoracic than on the abdominal region, where, as also on the thighs, they are more or less broken up into spots, which may

\* See Tenminck, Mon. Mamm. i. p. 128 (1827); and Fischer, Syn. Mamm. p. 208

or may not show signs of transverse linear arrangement. The neck and the shoulders may be striped or merely speckled. The fore and hind limbs are transversely barred; the former are typically black behind up to the wrist and the latter up to the hock. The tail also is transversely barred above, sometimes throughout its length, sometimes only in its distal portion, the tip being black.

In specimens that I regard as typical of this Cat the pattern is very similar to that of the European Wild Cat (*F. sylvestris*). In others the transverse stripes break up into more or fewer, larger or smaller spots. In others the spots are evanescent, the fur being merely "ticked," a gradation being traceable from the first or *sylvestris*-type to the last, which are, I believe, the so-called "Abyssinian" and "Ticked" breeds of the fanciers. I have obtained all these types from the Cats' Home in Camden Town, London, in the space of a few weeks, as well as a fine red variety of the spotted kind. With the exception of the *sylvestris*-type, all these phases can be matched approximately in the series of skins of *F. ocreata* preserved in the British Museum.

Specimens which are intermediate between the "spotted" and the "ticked" types—those, that is to say, in which the spots are very small and closely set, giving a blackish appearance to the skin except on the legs and ventral surface where the stripes are apparent—deviate from the normal in exactly the same way as the two South-African Leopards described by Dr. Günther\* differ from normally spotted Leopards.

In the British Museum Collection there are skins of this Domestic Cat from such widely separated localities as Crete, India, Madagascar, Celebes, and Mexico. The specimen from Celebes was shot on Bonthain Peak. It is noticeable that its stripes and spots are browner than in typical European examples; and in the skull the posterior portion of the nasals is more compressed and the interparietal crest is higher and traceable as a ridge all along the parietals. The narrowness of the nasals recalls that of the skulls of two Siamese Cats that I have seen (*cf. infra*, p. 163), and the height of the interparietal crest is paralleled in the skull of a rufescent Indian Cat † which formerly belonged to Mr. H. C. Brooke and was, I understand, a well-known prize-winner at Cat Shows some few years ago. For further information about *torquata*, see below, pp. 164–165.

The following description, taken from a number of skins, will perhaps convey a tolerably clear conception of the plan (*cf. text-fig. 60*, p. 154) to which the patterns of *F. catus*, however diversified in detail, are reducible:—

Ground-colour typically brownish or grey, frequently washed or clouded with blackish. Head and face normally striped. The internal or admedian cervical stripes abbreviated on the fore part

\* P. Z. S. 1885, p. 243, pl. xvi.; *id. op. cit.* 1886, p. 203, fig. See also W. L. Sclater, *Mamm. S. Afr.* i. p. 36, fig. 10 (1900).

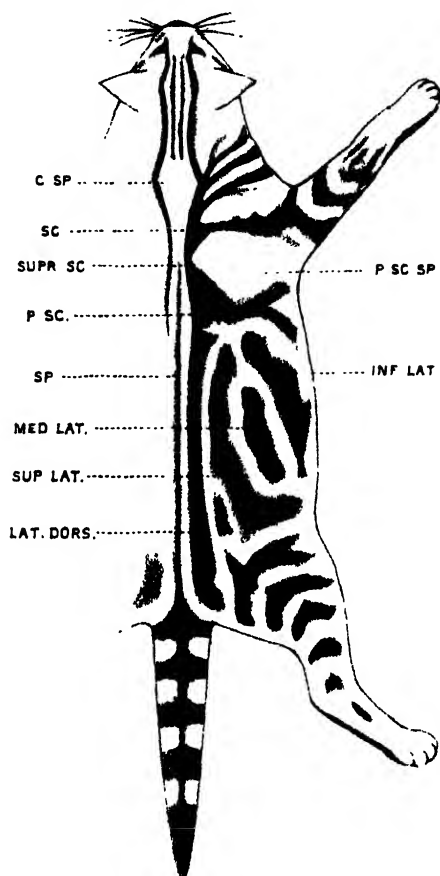
† This Cat, Mr. Brooke tells me, was brought as a kitten from a hotel in Bombay.

of the nape, and entering the anterior apex of a diamond-shaped space (*c.sp.*), which is bordered laterally by the posterior ends of the external cervical stripes and the anterior ends of a pair of broad suprascapular stripes (*supr.sc.*). The latter lie near the middle line on the summit of the shoulder, and diverge forwards to meet at an obtuse angle the posterior ends of the backwardly-diverging external cervical stripes. From this angle stripes pass obliquely forwards and downwards on to the sides of the neck and throat, the posterior of them lying in front of the shoulder and forming a throat collar. From the suprascapular stripe one broad vertical stripe, the scapular stripe (*sc.*), passes over the shoulder and loses itself in the uppermost of the transverse brachial stripes of the fore leg. This scapular stripe forms the anterior border of the postscapular space (*p.sc.sp.*), which is bounded behind by a second broad vertical stripe, the postscapular stripe (*p.sc.*), descending from the posterior end of the suprascapular stripe. Extending along the middle of the spine from the posterior apex of the cervical space there is a very narrow spinal or median dorsal stripe (*sp.*), which passes down the middle line of the tail. Running forwards on each side of this from the root of the tail to the posterior end of the suprascapular stripe, which it frequently joins, there is a very broad latero-dorsal stripe (*lat.dors.*). Beneath or externally to this on the body there are three broad stripes whose direction is obliquely longitudinal. The upper of these, the supero-lateral (*sup.lat.*), forms a bold downward curve posteriorly, while the inferior, the infero-lateral (*inf.lat.*), curves upwards anteriorly. They thus partially circumscribe an elliptical or subcircular area, in which lies the short and broad medio-lateral stripe (*med.lat.*), which frequently has the form of a large spot or blotch. These three stripes form the so-called "horseshoe," "circular," or "spiral" mark characteristic of this type of Domestic Cat. On the thighs there are broad transverse stripes, the upper of which, the femoral stripe, extends obliquely downwards and forwards from a point beneath the posterior end of the latero-dorsal stripe to a point beneath the downcurved posterior end of the supero-lateral stripe. In the space between the three stripes just mentioned lies a large spot or stripe, which frequently fuses with the femoral stripe. On both fore and hind legs the stripes thin out and die away towards the paws, which are typically black behind up to the wrist and hock. The tail is black at the tip, and marked throughout with transverse black bars, which are very broad where they touch the median caudal stripe.

The pattern of this Cat varies considerably in detail with respect to the width and degree of fusion of the stripes. The cervical and postscapular spaces are sometimes hardly apparent, and the stripes may widen and fuse to such an extent that an almost totally black Cat results. It is possible that the blackness of some Cats is attributable to this process; but usually the blackness is due to the melanism of the ground-colour, the stripes retaining their normal width and being detectable under

reflected light by the greater glossiness of the hair. The stripes in white Cats are often visible in the same way. Tortoise-shell variations of this Cat are nothing but partially erythristic or erythro-melanistic sports, frequently with pronounced albinism

Text-fig. 60.

Diagram of the Pattern of the Blotched Tabby (*Felis catus*).

*c.sp.*, cervical space; *p.sc.sp.*, postscapular space; *sc.*, scapular stripe; *supr.sc.*, supra-scapular stripe; *p.sc.*, postscapular stripe; *sp.*, spinal stripe; *lat.dors.*, latero-dorsal stripe; *sup.lat.*, supero-lateral stripe; *med.lat.*, medio-lateral stripe; *inf.lat.*, infero-lateral stripe.

affecting particularly the legs, inferior areas, and even other parts of the body. In simple cases the blotching may be seen to be due to the red tint occurring only on portions of the stripes, the remaining portions of which retain their normal black hue.

The result is a mixture composed of red and black stripes on a yellowish ground-colour. But in more complicated cases the red and black also invade the ground-colour in patches, either the red or the black, but more commonly the black, predominating. On these skins the original pattern is almost entirely obscured. It is a well-known but none the less singular fact that Tortoise-shell Cats are generally females and "red" Cats generally males. This circumstance is the foundation for the saying that the "red" Cat is the male of the "Tortoise-shell"; but since the Tortoise-shell is as much melanistic as erythristic, male black cats have equal claims to be so regarded.

3. *On the Characters of the European and African Wild Cats (F. sylvestris and F. ocreata) and the Origin of the Domestic Types (tyroquata and catus).*

Criticism of the opinions of authors on the subject of the origin of "Domestic Cats" must be prefaced by the remark that, with one or two exceptions, they failed to realise that an explanation was required of the origin of two distinct kinds of Cats differing so much from each other that no one would hesitate to regard them as representing widely divergent species if they occurred in a state of nature.

A great deal has been written on this topic. Opinions at one time were nearly equally divided on the point, some authors regarding the European Wild Cat (*F. sylvestris*), others the Egyptian Cat (*F. ocreata*) as the ancestral stock. Of late years, however, the latter species has grown greatly in favour for the distinction, partly on account of the unquestioned adoption and reiterated publication on the part of recent writers of a statement made many years ago, but none the less erroneous, that the Domestic Cat has a longer and more tapering tail than the Wild Cat of Europe\*, and partly on account of Nehring's assertion † that the Domestic and Egyptian Cats resemble each other, and differ

\* Macgillivray, in his excellent account of the British Wild Cat ('British Quadrupeds,' Jarline's Naturalist's Library, pp. 188-195, 1854), long ago pointed out that the tail of the Domestic Cat is thinner and more tapering than that of the Wild Cat, because its fur is much shorter. Dr. Hamilton also exposes the fallacy of the above-stated belief ('Wild Cat of Europe,' pp. 41-42, 1896). One modern writer speaks of the tail of the Wild Cat as "clubbed." I have never seen a specimen with a tail to which this epithet meaning broader at the tip than at the base could be applied.

† SB. Ges. nat. Freunde Berlin, 1897, pp. 26-27, & 'Humboldt,' 1888, pp. 139-141. Nehring (Zeits. für Ethnologie, xxi. pp. 558-9, 1889) suggests that Domestic Cats are descended from two main stocks—one from S.E. Asia, the other from N.E. Africa. From the former arose the "Chinese" Domestic Cat; from the latter the Egyptian House-Cat. The Egyptian House-Cat was the forerunner of the European Domestic Cat, with an infusion, especially in Germany, of the European Wild Cat. But whether the stock of the Asiatic House-Cat was *F. inconspicua* Gray, or *F. manul*, or some other smaller Asiatic species, the author leaves undecided. It does not appear that Nehring realised the existence of the two types of European Domestic Cats I have described. Also he can scarcely have been acquainted with the peculiarities of *F. manul* or with the nature of the affinity between *F. inconspicua* and *F. versata*.



from the Wild Cat in having the back of the hind leg from the hock to the pad blackish. This statement is negatived by three facts:—the area in question is not blackish in all Domestic Cats; nor in all examples of the Egyptian Cat; nor does it lack the dark tint in any specimens of the European Wild Cat that I have examined. The prevalent idea on this subject has been expressed as follows:—“The black sole of the foot suggests that the Caffre Cat is the chief stock from which the Domestic Cats of Europe have been derived”; and “that the European Wild Cat was not the direct descendant [? lapsus for ancestor] of the domesticated breeds of the western part of the continent is rendered pretty evident by its short and clubbed tail, to say nothing of the absence of dark soles to the hind feet”\*. And again:—“It has been maintained by many naturalists that the European Domestic Cat is chiefly derived from the north-eastern race of this species [*F. ocreata*] found in Egypt; at least, the domestic form is certainly not derived from the European Wild Cat”†. The foundation for this positive opinion entertained by Mr. Sclater may be found, I think, in his belief (Cat. Mamm. Indian Mus. ii. p. 934, 1891), taken from Blasius, that in the skulls of the Domestic Cat the frontal and squamosal bones are separated from one another by the parietals and alisphenoids, and the nasals are not produced posteriorly beyond the frontal processes of the maxillæ, the converse being the case in the Wild Cat. I have before me the skulls of four “London” Cats. In one of them the nasals project well beyond the maxillæ, in two as far back as the maxillæ, and in the fourth not so far. Again, the distance between the frontal and the squamosal is in one skull as much as 3 mm., in two others it is only about 1 mm. or less, while in the last the squamosal and frontal touch on one side but not quite on the other. Nevertheless, it is perfectly true that, as a very general rule, the squamosal and frontal are separated by the junction of the parietal and alisphenoid in Domestic Cats as they also are in *F. ocreata*. But this is also the case in both the skulls of the Scotch Wild Cat that I possess‡. In one of them the parieto-alisphenoid bridge measures 4 mm., in the other 2 mm. The bridge is also present in one of two skulls of this species in the Museum of the College of Surgeons, whereas in the other the frontal and squamosal have a long sutural union.

Thus, as Dr. Hamilton has already shown, the claims of both Blasius and Nehring regarding the differences above alluded to between the Wild and Domestic Cats of Europe will not stand the test of the examination of skulls and skins.

It appears to me that much barren discussion on this subject would have been saved by the realisation of the closeness of the affinity between the Egyptian and the European Wild Cats

\* ‘Cats &c.’ in Allen’s Nat. Library, pp. 156 & 157 (1896), by R. Lydekker.

† ‘Mammals of S. Africa,’ i. pp. 43–44 (1900), by W. L. Sclater.

‡ There is no reason to doubt that both these skulls belonged to pure-bred Wild Cats; this I can vouch for, since I have the skins.

(*F. ocreata* and *F. sylvestris*). The type of pattern they present is not found in any other species of *Felis*, the nearest approach thereto being that of the Tiger (*F. tigris*) and in a remoter degree of Pallas's Cat (*F. manul*). The similarity in pattern between the two, coupled with their geographical distribution, almost induces the adoption of the view that they are but northern and southern forms of the same species. There is as yet, however, no positive evidence that they actually intergrade to the extent of justifying the conclusion that their distinctive features are merely of sub-specific value.

The characters they have in common are as follows:—

Close resemblance in the shape, size, and structure of the skull and teeth\*.

General similarity in size and shape of the body, of the paws and ears, and in the length of the tail, though this organ is apparently a little longer at least in North-African examples of *F. ocreata* than in *F. sylvestris*.

General similarity in pattern: in both species the sides of the body are typically marked with wavy vertical dark stripes extending from the spine to the belly, and better defined, as a rule, on the thoracic than on the abdominal portion; the upper parts of both fore and hind limbs are transversely banded with broad bars, almost always darker than the transverse stripes on the body; the fore leg is black below from the toes to the wrist and behind at the elbow, the two internal brachial stripes, normal in felines, being well developed; the hind leg is normally blackish below from the toes up to the hock. The distal portion of the tail has a black tip and about three well-defined black stripes preceding it, the proximal portion of the tail being much less distinctly barred and marked at best with an ill-defined median dorsal stripe. The throat is unstriped or only indistinctly striped, and usually exhibits a white spot; the thoracic and anterior abdominal areas of the ventral surface are spotted; the posterior abdominal and inguinal areas are unspotted and tinged with yellowish buff, especially on the inner side of the thighs. Identity prevails even in the colour of the individual hairs, which are slate-grey at the base, then buff or cinnamon, then black, the distal portion being yellowish or greyish white with a black tip.

The principal differences between them are as follows:—

In *F. sylvestris* the four paired stripes on the head and neck are well defined; on the occipital region they diverge from the middle line and run backwards almost to the shoulder as four wavy widely

\* Amongst the skulls in my own collection and in that of the British Museum I have so far failed to find any constant characters for distinguishing the two species. By the sum of a number of small features in the teeth and bones, the skull of *sylvestris* can generally be recognised from that of *ocreata*. But up to the present every character which I thought might prove to be distinctive of *sylvestris* has broken down under the examination of a long series of skulls of *ocreata*, a species which, in its broad sense, is extremely variable in its cranial osteology. So far as the skull is concerned, the differences between the two species must be regarded as of "subspecific" value.

separated stripes, the admedian pair being, as a rule at all events, better emphasised than the laterals, which lie quite at the sides of the upper surface of the neck. In *F. ocreata* the head- and neck-stripes are usually badly defined; when present on the neck they are narrow and lie close together.

In *F. sylvestris* there is generally a very distinct black wavy median spinal stripe, usually extending from behind the shoulders to the root of the tail. In *F. ocreata* the entire spinal area is markedly darker than the sides of the body, sometimes showing traces of three narrow stripes; but the median is never so strong as in *F. sylvestris*. In the latter, however, a pair of narrow interrupted latero-dorsal stripes is sometimes traceable.

These are the most obvious distinctions. Others are less constant. For instance, in *F. sylvestris* the ears are, generally speaking, of the same colour as the head, though not infrequently they are washed with yellow either all over or only towards the tip. In *F. ocreata* they are almost always yellower or redder, generally very decidedly so, especially in African specimens; but, on the other hand, in an example of *F. ocreata sarda* in the British Museum the yellow on the ear is no more conspicuous than it is in some examples of *F. sylvestris*.

In *F. sylvestris* the coat is longer and thicker than in *F. ocreata*. This imparts to the former Cat a heavier, more robust, and shorter-legged appearance, and especially suggests that the tail is blunter at the apex\*. The value of this difference is discounted by the fact that *F. sylvestris* is a more northern type than *F. ocreata*†, and that the length and density of the fur varies a good deal in the latter, which appears to be a species endowed with great capacity for environmental adaptation both as regards coat and colour.

Yet, in spite of the obvious resemblances above mentioned, the assumption of the total diversity of the two forms seems to have been pretty general, if we may judge by the absence of all comparison between them in monographs of the Felidae.

Now the characteristics which the Egyptian and European Wild Cats have in common are all possessed by the Domestic Cats of the "striped" type; and they are not found in any other species of *Felis* known to me. Hence there is no difficulty in the way of believing that our "striped" Cat is the direct and but little modified descendant of either *F. sylvestris* or *F. ocreata*, or probably of both combined. *F. sylvestris* inhabits Spain, Italy, Greece, and Asia Minor; and *F. ocreata* Egypt, Tunisia, Algeria, and Sardinia. Thus one species or the other is found in the countries bordering the Mediterranean basin, where the civilisations of Europe had their origin. If Egyptian Cats were taken to Greece, Italy, or

\* Quite similar differences in the thickness of the tail may be seen in Siberian and Indian Tigers.

† A very good description and an excellent figure of this species may be found under the name *Felis lybica* in Anderson's and de Winton's 'Mammals of Egypt,' pp. 171-176, pl. xxiv. (1902).

Spain, it is highly probable that they interbred with the native Wild Cat, especially at a time when the latter was far more abundant than it is now and when precautions to prevent the tame animals from straying are not likely to have been rigidly observed. But even if such crossing took place, I do not believe its effects could be traced in the progeny with any certainty, on account of the resemblances between the parent forms.

It may however, in my opinion, be assumed that the differences our English striped Domestic Cats exhibit from *F. sylvestris* on the one hand and from *F. ocreata* on the other, coupled with an unmistakable likeness to both, are attributable to that cause. To assume that the striped pattern of this Cat is due to interbreeding between domestic "Tabbies" or Blotched Cats and specimens of *F. sylvestris*, needlessly complicates a quite simple question.

It is difficult to decide which of the two species our Striped Cats most resemble. Typical short-haired individuals recall *F. ocreata* in the length of the fur on the body and tail; whereas in the colour of the ears greater similarity is presented to *F. sylvestris* than at all events to African examples of *F. ocreata*. In the proximity of the stripes on the neck, resemblance is evinced to *F. ocreata*; but their distinctness recalls, though in a lesser degree, those of *F. sylvestris*. In the distinctness of the spinal stripe, the domestic form lies nearly midway between the two; but the transverse stripes on the body and tail are as a rule more sharply defined than in typical members of either of the wild species: but their want of definition in some long-haired specimens is quite paralleled by that of *F. sylvestris*, and suggests that their indistinctness in the latter is attributable to length of fur.

In the length of the tail the Striped Cat seems to be nearer *F. sylvestris*. There is no evidence that this organ is shorter in the domestic form than in the wild species just mentioned; whereas in North-African examples of *F. ocreata* the tail is longer than in either of those types\*.

In connection with the likeness this Cat presents both to *Felis ocreata* and *F. sylvestris*, it is apposite to note that out of four authors who have described specimens under the belief that they represented wild species or races, two compared them to *F. sylvestris* and two to *F. ocreata*. Blyth †, speaking of an example from the Punjab Salt Range, says "it is of the streaked or spotted type, the colouring and markings of which are not much unlike those of the European Wild Cat (*F. sylvestris*)"; and Mivart ‡, in his description of *F. torquata*, remarked, "this Cat has much resemblance to the European Wild Cat." Blanford, on the contrary, says "the characters of the upper premolars distinguish *F. torquata* from the allied *F. caffa* (or *caligata*) [= *ocreata*]" § ;

\* Anderson and de Winton, 'Mammals of Egypt,' p. 172.

† J. A. S. Beng. xxv. p. 442 (1856).

‡ 'The Cat,' p. 420 (1881).

§ 'Mammals of British India,' p. 96 (1888). The character Blanford refers to is the nearness of the first maxillary premolar to the second—a very variable feature in the skulls of Domestic Cats and also, though in a lesser degree, in those of *F. ocreata*.

and Miss Bate described a specimen from Crete as the type of a distinct subspecies of *F. ocreata* \*.

The origin of *F. catus* appears to be at present quite unknown. It may be held:—

- a. That it arose *per saltum* as a sport from the other Domestic Cat (*torquata*), and that the pattern persisted in virtue of its own inherent dominance without the aid of Man, or in virtue of the guiding factor of selective breeding. In opposition to this must be urged the complete absence of evidence that species of *Felis* are ever dimorphic in pattern, and the ascertained fact that they breed true to the specific or subspecific type.
- b. That it arose from *torquata* by the slow and gradual process of preserving and breeding from fancied varieties. But in answer to this it may be pointed out that there is no reason to think that selective breeding of Cats was ever seriously practised until the latter portion of the nineteenth century. Moreover, if the *catus* type arose by that process, intermediates between it and *torquata* would probably be seen everywhere.
- c. That it resulted from the interbreeding of *F. ocreata* and *F. sylvestris*. When two distinct species cross, the hybrid sometimes reverts in some respects to the characters of a common ancestor of both. There is no reason, however, for thinking that the pattern of *catus* was the pattern of the ancestor of *sylvestris* and *ocreata*; and it seems to be in the highest degree improbable that the progeny of two closely allied and similarly striped species like *sylvestris* and *ocreata* should be marked in a totally different manner from its parents. There is, moreover, good reason for thinking that the *torquata*-breed was the resulting hybrid of that cross.
- d. That it resulted from interbreeding between *sylvestris* or *ocreata* or *torquata* and some exotic species introduced into Europe. There is, however, no reason to believe that either tamed or wild representatives of any exotic species other than *ocreata* were so introduced, apart from menagerie-kept animals.
- e. That it is the direct descendant of some existing exotic species. It is quite evident, however, that it is not the direct unmodified descendant of any known species of *Felis*, since its pattern is unique in just the same way and to the same extent that the pattern of the Tiger is unique in the genus.
- f. That it is the survivor of some extinct, probably Pleistocene Cat of Western Europe. By the method of exhaustion of other possibilities, one falls back upon this supposition, which at least has this in its favour, that no very obvious or cogent reason can be advanced against it.

\* P. Z. S. 1906, p. 317.

#### 4. On Manx, Persian, Siamese, Indian, and Abyssinian Breeds.

As already explained, "Manx" Cats may be either of the *catus* or *torquatus* type. Apart from the abbreviated tail, which has been discussed and dismissed as of no systematic significance from the zoological standpoint, Manx Cats differ or are alleged to differ from ordinary short-haired Cats in standing relatively higher at the hind-quarters. I have not seen any measurements substantiating this claim; and it is difficult to decide to what extent the greater apparent posterior stature is an optical illusion caused by the absence of the tail. It is quite possible, however, that suppression of the tail is correlated with greater height at the sacrum, and that, to put it crudely, the caudal material is distributed to or absorbed by the hind-quarters. Some Lynxes certainly seem to stand higher on the hind legs than the majority of species of *Felis*. Be this as it may, the circumstance that height at the posterior region is considered by fanciers "a point" in the Manx breed throws the fact - if fact it be - under suspicion of having been fostered by selective breeding and of being therefore unworthy of consideration from the phylogenetic and systematic point of view, zoologically speaking. In other words, as little importance should be attached to the character as to the absence or abbreviation of the tail.

With regard to so-called "Persian" or "Angora" Cats\*, there seems to me to be no reason to suppose that any other species is involved in their ancestry than in the ancestry of the short-haired breeds most common in Europe. Both the "blotched" and the "striped" styles of pattern occur; and no other type of pattern is known amongst them, so far as I am aware. The skull, moreover, is not distinguishable from that of short-haired Domestic Cats. The small systematic value that should be attached to the long coat has been already insisted upon. Nothing seems more likely than that tame Cats were imported from Egypt into Persia; the European Wild Cat (*F. sylvestris*) occurs both in Asia Minor and Persia, and *F. ocreata* has been recorded from Syria and Arabia. Hence it seems needless to look beyond the two species just mentioned for the origin of "striped" "Persian" Cats, even on the supposition that they came originally from Persia. That the "blotched" Persians had the same origin, whatever that may have been, as the "blotched" short-haired Cats is in the highest degree probable. For myself, I think it quite needless to consider that so trivial a character as long hair is to be traced in all cases to Cats imported into Western Europe from Asia Minor or Persia. The suggestion - first made, I believe, by Pallas, but repeated even in modern literature on the subject - that the Central Asiatic species, Pallas's Cat (*Felis manul*), contributed to the "Persian" breed, has nothing to be said in its favour. *Felis manul* is quite unlike all domestic breeds.

\* Desmarest (Nouv. Dict. vi. p. 122, 1816) gives Anatolia as the original country of this breed.

The ears are small and set very low on the sides of the head, leaving a great width of forehead between them; the facial and body markings are different; and, lastly, the pupil of the eye contracts to a circular disk\*.

There is, however, one species of *Felis* which must not be altogether forgotten in considering the possible origin of Persian Cats. This is the Bokhara Steppe Cat (*Felis caudata*), described by J. E. Gray (P. Z. S. 1874, pp. 31-32, pls. vi. & vii.). The type is in the British Museum. The figures of the entire animal and of the skull show that this Cat is closely related to *Felis sylvestris* and to *F. ocreata*, and not to *F. chaus*, with which Dr. Gray compared it. It has a thick coat and bushy tail, like *F. sylvestris*; but there are no distinct spinal stripe nor definite stripes on the head and neck. In length the tail resembles that of *F. ocreata*; and likeness to this species is further shown by the indistinctness of the head, neck, and dorsal stripes. From both the other species it differs in being covered with small spots; but these spots, at least on the anterior part of the body, show, I think, signs of the coalescence into transverse rows which is realised in *F. sylvestris* and *F. ocreata*. Gray describes the colour as yellowish. The skin, which is probably faded, might be more aptly described as "ounce"-grey. Whether or not this species has any connection with the "spotted" Cats of the Punjab Salt Range, mentioned below (p. 164), I am unable to say.

It is worth putting on record the fact that in two out of the three skulls of "Persian Cats" I possess the jaws are slightly "underhung," that is to say, the mandible protrudes a little in front of the premaxillæ. I have not noticed this peculiarity in the skulls of any other Cats, either wild or domestic. It may be purely accidental, or it may indicate that the taste of fanciers in Cats is running along the same lines as those of breeders of Domestic Dogs. In this case we may in the future have a race of snub-nosed Cats departing in facial elegance from Nature's type of *Felis* in the same manner that Pugs and Bulldogs depart from Nature's type of *Canis*.

The origin of the Siamese breed has been a much-discussed puzzle. The peculiar coloration† must be set on one side as valueless towards affording a clue. The cats are obviously albescent, as is attested by the hue of the hair and frequently by the blueness of the eye‡. But the albescence, complete in the newly-born kitten, is mitigated as age advances by a melanistic taint which evinces itself in two ways, both of unusual occurrence in Nature. In the first place, the black pigment is distributed symmetrically, and primarily affects the face and ears, the tail, and the legs.

\* The illustration of this species in Elliot's 'Monograph of the Felidæ,' pl. v., was taken from a stuffed specimen, and does not correctly depict the peculiarities of the head and eyes. Elliot, however, very rightly insists that this Cat is unlike all other known species.

† Mr. E. G. B. Meade Waldo has reminded me that the so-called Himalayan breed of domestic rabbits is almost identically coloured.

‡ R. I. Pocock, Ann. Mag. Nat. Hist. (7) xix. p. 194, 1907.

In the second place, it increases in quantity as age advances, and gradually encroaches upon the whiter areas, converting the hair of the body from whitish or pale fawn into pale or dark brown. Sometimes there are indistinct traces of spots on the hind-quarters and legs.

Judging from their size, form, and general aspect, I should say these Cats are nothing but a domestic variety of *F. ocreata*. The only skull of this breed that I possess \* is that of a female with its contours and ridges indicating considerable muscular development. It is a short, broad skull, with expanded zygomata, and beyond all possibility of doubt falls into the group typified by *F. ocreata* and *F. sylvestris*. In profile it is noticeable that the highest point of the cranium lies well behind the fronto-parietal suture, and that the area in front of that point, almost as far as the nasals, is nearly flat and slightly inclined. This is not a common feature in the skulls of Domestic Cats; but it is almost exactly paralleled in the skull of an old male specimen of *F. ocreata* from Suakin, and does not occur in the skull of a Siamese Cat in the British Museum, in which the highest point of the skull is on the frontal bones, which are evidently swollen just behind the postorbital processes. Another peculiarity in my specimen is the division of the infra-orbital foramen by a bridge of bone. I find this feature repeated, however, in the skull of a London Cat not referable to the Siamese breed; and it does not occur in the Siamese skull in the British Museum.

Nevertheless, these two Siamese skulls agree in the possession of two small characters, one of which I can only match in one of the English Cats' skulls I possess, while the other cannot be quite matched in any of them. The first character is the height of the interparietal crest, which is better developed than is usually the case in English Domestic Cats, though it is equalled in the skull of one London Cat that I have seen, and of one feral example of the *torquata*-type of *F. ocreata*, from Celebes, in the British Museum. The second character is the greater narrowness of the posterior portion of the nasal bones and the more marked abruptness of the constriction between this portion and the expanded anterior portion. But since the two Siamese skulls differ in degree with respect to this character, and since the nasal bones vary greatly in length and width in English Domestic Cats, no great importance can, I think, be attached to the feature in question. Moreover, as already stated (p. 152), the Celebes example of *torquata* in the British Museum also has the nasals compressed.

Since, therefore, the colour of the Siamese Cat affords no evidence of its descent, and the skull is decidedly of the *ocreata* + *sylvestris* type, there seems to me to be no reason to look beyond those species or indeed beyond *ocreata* for its origin. Those who claim that it has had an origin independent of our own Domestic

\* I am indebted to Mr. F. W. Cousens, F.Z.S., for the skin and skull of one of the two specimens of this breed I have been able to examine. Mr. Cousens also kindly gave me the skins and skulls of two Persian Cats.



Cats from some Siamese or Oriental species, must be challenged to produce that species before the question can be profitably discussed. There seems to be no reason whatever for entertaining Trouessart's suggestion\* that the rare Bornean *Felis badia* was its agriotype. I may add that all the small species of *Felis* inhabiting Siam, including even *F. chaus*, which is doubtfully indigenous, differ in the structure of the skull and teeth from the Siamese Domestic Cat †.

According to Blyth (Journ. As. Soc. Bengal, xxv. pp. 442-445, 1856) two types of Domestic Cat were prevalent in India in his time. "One is the streaked or spotted type, the colouring and markings of which are not much unlike those of the European Wild Cat (*F. sylvestris*), only more distinct, and the transverse streaks are more broken into spots, especially towards the hinder part of the body; the fur, however, is short, and the tail ‡ slender and of uniform apparent thickness to the end, showing a series of rings and a black tip; ears slightly rufescent externally but infuscated, but passing to black at tip, where there is a distinct small pencil-tuft of black hairs. Paws deep sooty black underneath." Two examples of this Cat were shot wild in the Punjab Salt Range; another seen at Allahabad in a state of domestication exactly resembled them; but the tame Cats of Calcutta were usually greyer, with smaller and more numerous spots.

The other type, says Blyth, resembles the Jungle-Cat (*F. chaus*) in colour, the body being uniformly "cat-grey," more or less rusty or fulvescent, without a trace of spots or stripes, but the stripes on the tail and limbs are more distinct; there are also confused stripes on the forehead and two on the cheeks and a dark band across the chest; the lower parts are whitish or tinged with tawny, and spotted; the ears are dull rufous behind with a slight blackish tip and no pencil of hairs; the paws more or less sooty beneath. In its proportions, however, this Cat is quite different from *F. chaus*, the limbs and ears being much shorter, and the tail much longer and tapering. Blyth adds that Domestic Cats of this type abounded in Bengal, if not all over India, but were quite unknown in Europe; whereas, on the other hand, the English "tabby" was quite unknown in India.

Mr. W. L. Sclater also discussed these two breeds, and accredited Blyth with the belief that the self-coloured "*chaus*"-like type was derived from interbreeding between the "Domestic" Cat and *F. chaus* (Cat. Mamm. Ind. Mus. ii. p. 233, 1891). He also suggested that the form named *F. torquata* by F. Cuvier was based upon a feral example of the spotted or streaked breed.

So far as I can judge from what the two authors quoted say about these breeds, there is nothing to distinguish them from

\* Cat. Mamm. 1904, p. 273.

† For list of the species, see S. S. Flower, P. Z. S. 1900, pp. 322-327.

‡ In this particular the tail must resemble and not differ from that typical of *F. sylvestris*. Surely Blyth intended to say "tapering" towards the end, otherwise the remark is pointless.

*F. ocreata*, which may be either self-coloured like the "*chaus*"-like Cat or spotted and streaked like the spotted Indian Cat. The facts adduced do not appear to me to supply any evidence that such indigenous Indian Cats as *F. rubiginosa*, *F. chaus*, or *F. bengalensis* have contributed to the strains; and I strongly suspect that they have been derived from *F. ocreata* either by the importation of tamed specimens or by the reclaiming from the wild state of examples of this species which may have inhabited India in comparatively recent times.

In the British Museum there are a few skins of Indian Domestic or semi-domestic Cats belonging to the spotted or striped and to the self-coloured types mentioned by Blyth. An examination of them fully confirms the opinion I had formed from reading Blyth's remarks. Those belonging to the striped or spotted type are, as Mr. Schlater suggested, the same as the form described by Cuvier as *torquata*. Those of the self-coloured type do not differ from them more than some of the self-coloured Cats differ from the striped Cats to be seen in the London streets. Some of them are more rufescent than others; but I cannot find in them a particle of evidence of partial descent from *F. chaus* or from any other indigenous Indian species.

Not uncommonly Indian Domestic Cats differ from typical English examples of *torquata* in having the bands on the tail narrower and the stripes, especially on the forehead and cheeks, more rufous. The narrowness of the caudal stripes arises from the splitting of the normal stripes; but this character as well as the rufescence may be seen in African examples of *F. ocreata*. There is no reason, therefore, to doubt that the Indian Domestic Cats are descended from that species. It must, of course, be conceded that they may interbreed with indigenous Indian species, and especially with the so-called Desert-Cat (*F. ornata*), which, from the structure of the skull and teeth, as well as from other characters, must be regarded, I think, as the Indian representative, as *F. caudata* is the Bokhara representative, of the group typified by *F. ocreata* in Africa, and by *F. sylvestris* in Europe.

Cats of the so-called "Abyssinian" breed may be descended, for anything I know to the contrary, from specimens of *F. ocreata* directly exported from Abyssinia. They are certainly not unlike some self-coloured examples of that species. On the other hand, it would I imagine be difficult to separate them from fulvescent "Ticked" Cats, which appear to me to be nothing but examples of the *torquata*-type in which the pattern is broken up and evanescent (see p. 152).

##### 5. On alleged Cases of Interbreeding between Domestic Cats and various wild Species of the Genus *Felis*.

It has been stated over and over again that Domestic Cats interbreed freely with the native Cats of various species inhabiting the countries to which they have been transported. One cannot

help wishing there was more positive evidence of the fact. It may be so; but the statements of authors on this subject cannot be accepted as of any great value unless there is collateral evidence of their intimate acquaintance with the wild species in question and with the range of variation in colour, pattern, and structure of the domestic breeds. Many alleged cases of interbreeding may be found quoted in Darwin's 'Variation of Animals and Plants under Domestication.' It is very likely that some Cats seen by Jardine in the north of Scotland were rightly regarded as hybrids between domestic animals and *F. sylvestris*. And St. Hilaire's statement that the Domestic Cats of Algiers cross with the native Cat (*F. lybica* = *ocreata*), and Layard's to the effect that similar crosses occur with *F. ocreata caffra* in S. Africa, may also be true. But in the last two cases it may be doubted if evidence of the crossing would be shown by the progeny; and as regards Jardine's alleged hybrids, long-coated specimens of the "striped" Domestic Cat might easily be mistaken for half-feral Wild Cats. A striped Cat known to be descended from a feral specimen was recently caught in the New Forest, where *Felis sylvestris* has not occurred for at least a century, and sent to the British Museum by Mr. P. H. Barker as a hybrid. On the strength of its long coat, it must be regarded as a "half Persian." Had it come from parts of the north of Scotland, where *F. sylvestris* still lingers, the entire purity of its descent might have remained for ever in doubt. As regards the claim that Domestic Cats in India interbreed with the Jungle-Cat (*F. chaus*), I am unable to find evidence that satisfies me of the certainty of this occurrence (*cf. supra*, p. 165). In one case the claim is actually based, in part at all events, upon the occurrence of the internal brachial stripe on the fore leg, a feature regarded by the observer as characteristic of *F. chaus*, whereas it is the most persistent of all the stripes in the genus *Felis*.

No one would be so rash as to affirm that interbreeding does not occur between Domestic Cats and even widely different wild species. But unless the skins and skulls of alleged hybrids are forthcoming for examination, there is no basis for the discussion of the question. Vague suppositions of observers cannot be regarded as evidence of the fact; and I am of opinion that the prevalent beliefs on the subject are to be assigned in a great measure to the observation of semi-wild specimens of the common but little known striped Domestic Cat, which may be either red or grey in colour, and either striped or spotted in pattern.

#### 6. Summary.

The substance of the foregoing remarks may be epitomised as follows:—

1. The characters used by breeders and fanciers as a basis for their so-called breeds of English Domestic Cats have no scientific value, in the sense of affording a clue to affinity and descent.

2. The pattern—or, in other words, the arrangement of the stripes—shows that English Domestic Cats are referable to two distinct types, whether they belong to the “Manx,” “Persian,” or “Short-haired” breeds.
3. These two types of pattern are different in kind and do not intergrade. They are so distinct from each other that no one would hesitate to regard them as characterising two well-marked species if the animals presenting them existed in a wild as opposed to a domesticated state.
4. In one type of pattern the stripes take the form of narrow transverse or vertical bands which sometimes break up into spots. To feral or domesticated examples of this Cat have been given many names, of which *torquata* is the best known and *angorensis* or *striata* possibly the oldest.
5. This Cat (*torquata*) was apparently domesticated in Europe at least as early as the 16th century. There seems to be no reason therefore for regarding it as of Indian origin.
6. It closely resembles in pattern two existing species, namely, the so-called Egyptian Cat (*F. ocreata*) and the European Wild Cat (*F. sylvestris*), both of which occur at the present day in the Mediterranean Region, and are very nearly related to each other. There is no difficulty in the way of believing that they are the ancestral forms or “agriotypes” of this domesticated race (*torquata*).
7. In the other type of pattern the stripes take the form of broad longitudinal or obliquely longitudinal bands forming a ring-like or spiral arrangement on the sides of the abdomen. To domesticated examples of this Cat, Linnaeus gave the name *catus*, which cannot be applied to any other form of the genus *Felis*. *Domestica* is its best-known synonym.
8. This Cat (*catus*) is certainly known to have been domesticated in Europe in the middle of the 18th century. It was not, however, apparently known in India in the middle of the 19th century. Probably, therefore, it is of European descent.
9. Its origin is unknown. Of the several hypotheses that may be held on this subject perhaps the following two are the most to be commended:—that it arose as a sudden variation or sport from the *torquata*-breed, in which case European Domestic Cats are dimorphic in pattern; that it is the direct descendant of some extinct Pleistocene Cat, in which case there are two distinct species of Domestic Cat in Europe.

#### EXPLANATION OF THE PLATES.

##### PLATE VIII.

##### Blotched Tabbies, *Felis catus*.

The four skins photographed were selected out of a large number to show the principal variations to which the pattern in this Cat is liable. All came from the Cats' Home in Camden Town, London.

## PLATE IX.

Striped Tabby, *Felis tigrata*.

- Fig. 1. Example of the *Felis sylvestris*-type to be compared with fig. 1, Plate X.  
 2. Like the last, but the pattern more spotted.  
 3. A partially albino specimen with the spots larger and more widely spaced than in No. 2.  
 4. Specimen of the so-called "Ticked" breed, with the spots disintegrated and generally distributed over the body.

(From the Cats' Home, Camden Town.)

## PLATE X.

Agriotypes of the Striped Tabby, *F. tigrata*.

- Figs. 1 & 2. European Wild Cats, *F. sylvestris*, from Ross-shire in Scotland.  
 Figs. 3, 4, 5. Young examples of the South African race of the African Wild Cat, *Felis orreata caffra*. The pattern is usually more distinct in the young than in the adults of this species. The exact locality of these three specimens is unknown. They were shipped from Cape Colony.

(The camera has emphasised the pattern of the skins depicted on this Plate.)

## 2. Report on Deaths occurring in the Society's Menagerie during 1906. By C. G. SELIGMANN, M.D., F.Z.S., Pathologist to the Society.

[Received February 19, 1907.]

(Text-figure 61.)

In the annexed table will be found the causes of death so far as they could be discovered of 355 mammals and 283 birds which died in the Society's Gardens, and which were submitted to post-mortem examination during the year 1906. In these mammals and birds no cause of death is stated to have been found in 36 mammals and only one bird, but it must be noted that the number of deaths put down to trauma and exhaustion is much larger than in 1905. This is due, in my opinion, to the important part played by depressed vitality, and in some cases darkness and cold, in bringing about death. The method of classification is the same as that adopted last year\*, but two new headings occur, viz. Diseases of the Ductless Glands and Deaths due to Old Age. Possibly two of the deaths among birds attributed to "trauma and exhaustion" really took place owing to the effect of parasites.

The following remarks refer to conditions of special pathological interest occurring in the animals in the Gardens.

*Tuberculosis*.—It is yet too early to attempt any full appreciation of the effect of thoroughly disinfecting, scraping, and repainting the monkey-house, undertaken early in the year, when the heating arrangements also were altered, but the diminution of deaths from tuberculosis—34 in 1906 against 53 in 1905—is decidedly encouraging. If the figures be expressed as percentages, 21·6 of the total deaths in monkeys were from tuberculosis in 1906 against

\* "Note on Deaths occurring in the Society's Gardens during 1905," P. Z. S. 1906, p. 234 *et seq.*

	PRIMATES.	CARNIVORA.	RODENTIA.	UNGULATA.	CHIROPTERA.	MARSUPIALIA.	EDENTATA.	BIRDS.
<b>I. General Diseases.</b>								
Rickets .. . . .	17	1	1			...		5
Anemia .. . . .	4							5
Gout .. . . .	34	1	4	3				6
Tuberculosis .. . . .	6	3		3		1	1	86
<b>II. Diseases of the Respiratory System.</b>								
Septicæmia and Pus infections .. . . .								1
Laryngitis .. . . .	4	1		4				
Bronchitis .. . . .	19	16	6	10	1		1	14
Broncho-pneumonia .. . . .	2	1	1	1				
Pneumonia .. . . .								
Pleurisy .. . . .								
Emphysema .. . . .	3	3				1		
Congestion of Lungs, including Hypostatic congestion .. . . .								
<b>III. Diseases of the Circulatory System.</b>								
Mycosis .. . . .								10
Pericarditis .. . . .	1	1	1	1				21
Valvular disease of Heart .. . . .								
Myocarditis .. . . .		4				1		
<b>IV. Diseases of the Digestive Organs.</b>								
Arterial disease .. . . .								
Stomatitis .. . . .	1							
Gastritis .. . . .	1							
Gastric Ulcer .. . . .	5	2						
Gastric Hemorrhage .. . . .	16	4						
Enteritis .. . . .	11	2	5	2	1	4	1	10
Colitis and Dysentery .. . . .		2	1	1		1		1
Intussusception .. . . .								
Obstruction .. . . .	1	3						
Peritonitis .. . . .	1	1						
Fibrosis of Liver .. . . .	7	3	3			2		3
Fatty Liver, including Jaundice .. . . .								1
<b>V. Diseases of the Urinary System.</b>								
Nephritis .. . . .	1	1						2
<b>VI. Diseases of Ductless Glands.</b>								
Goitre .. . . .								
<b>VII. Diseases of the Nervous System.</b>								
(A) Brain .. . . .	1							
(B) Cord .. . . .								
(C) Peripheral Nerves .. . . .								
<b>VIII. Diseases of the Reproductive System.</b>								
IX. Deaths due to Parasites .. . . .	7	27	8	8	1			1
X. Deaths due to Trauma and Exhaustion .. . . .		9	8	4		3		105
XI. Deaths due to Old Age .. . . .						2		
XII. Deaths, Parasites, unclassified and intermediate .. . . .	15	8	7	6				1
<b>TOTAL</b> .. . . .	<b>157</b>	<b>92</b>	<b>41</b>	<b>43</b>	<b>3</b>	<b>15</b>	<b>4</b>	<b>283</b>

35·8 in 1905. Assuming that there were about 100 monkeys in the house on January the 1st, 1906, between 16 and 17 per cent. of the inmates of the house have died of tuberculosis during the past year, since the actual number of monkeys received was 105.

My thanks are due to Mr. Pocock for ascertaining the number of admissions during the year, and I am further indebted to him for the estimate of 100 as the number of monkeys in the house in January 1906.

Much attention has been paid to tuberculosis in birds, and certain interesting conclusions concerning avian tuberculosis can be drawn from a study of the material available. It must in the first place be noted that during the past two years about 30 per cent. of all deaths in birds have been due to tuberculosis; and the more the matter is investigated the more obvious it becomes that a very large percentage of the cases of tuberculosis occurring in birds in the Zoological Gardens are the result of infection by the intestine, which can hardly be due to any other cause than the swallowing of particles of contaminated soil while food is being picked up. By far the greater proportion of birds dying of tuberculosis in the Gardens present typical lesions in their spleen and liver, which can only be explained on the hypothesis of an ingestion tuberculosis: sometimes the intestine is affected, but more often this is not the case, and typical tubercular ulceration of the gut in birds dying in the Gardens is rare. But although ulceration of the gut does not frequently take place, enlarged tuberculous glands at the root of the mesentery are by no means uncommon; a condition akin to *tabes mesenterica* of human pathology being set up without obvious damage to the mucous membrane of the gut, but with the addition of lesions in the spleen or liver or both. Even where the intestine is affected, ulceration is rare or slight; comparatively large submucosal nodules being formed over which the villi of the mucous membrane often seem enlarged, so that a curious condition suggestive of multiple closely-set warts is found to occupy the inner surface of the bowel. Sometimes, as in a Vulturine Guinea-fowl (*Acryllium vulturinum*), the whole of the large gut may be thickly studded with these warty growths, which on section are found to contain dense masses of acid-fast bacilli. In other cases the whole of the small gut is similarly affected, as in a Burmese Slaty-headed Parakeet (*Palæornis* sp.). In the latter case it was interesting to note that there were no lesions in any other abdominal organ or in the thorax, while in the case of the Guinea-fowl there was early tuberculosis of the lung, liver, and spleen.

*Pneumonia and Broncho-pneumonia.*—No marked improvement in these diseases has followed the cleaning of the monkey-house.

*Mycosis.*—Reference was made last year to the occurrence of a disease, mycosis, which was due to the invasion of the tissues by a mould, *Aspergillus fumigatus*. This disease is by far commoner in water-fowl than in other birds, and when attacking these its characteristic lesions are usually widely distributed throughout the body-cavity; but a case occurred in an African Buzzard (*Buteo*

*desertorum*) in which the disease, obviously not very recent, affected only the air-sac and the lung of the right side, there having been no extension of the parasite by continuity or by infection of the blood or lymph stream.

*Cardiac Failure.*—It has been noted in the case of Ostriches, Rheas, and Cassowaries, as well as some of the larger Storks kept

Text-fig. 61.



Aorta of Tiger, showing several aneurysms.

in the Gardens, that their hearts after death are usually extremely flabby, while the subpericardial fat may be replaced by a loose-



meshed oedematous tissue; so that probably cardiac failure is the direct cause of death of many of these birds, the condition perhaps being due to lack of exercise. One case of particular interest as bearing out this view has occurred during the past year. While some Zebras were being moved into the new enclosure in the neighbourhood of the Seal pond, an Emu (*Dromæus novæ-hollandiæ*), so placed as to be able to see what was happening, became extremely excited, and running round its paddock either struck the railings and collapsed against these or else collapsed and fell against the railings. In any case it could hardly have been injured by the blow, since its feathers were not damaged or its skin torn. On picking it up it was found to be quite dead, but at the post-mortem examination no sign of disease could be found in the brain, or abdominal organs, nor was the heart notably flabby.

*Arterial Disease.* The aorta showing many aneurysms of an old Tigress, which had lived in the Gardens for 13½ years, was shown at one of the evening meetings of the Society, and a brief note upon the condition appeared in the 'Proceedings'\*. An illustration has since been prepared which is reproduced in text-fig. 61, and shows the unusual condition of the vessel, the previous description of which may be quoted here:—"The aorta shows advanced arterial disease, most pronounced in the descending aorta, where there is marked atheroma and where, in a length of about 180 mm., there are 14 aneurysmal swellings varying in size from that of a pen to that of a fair-sized plum. The two largest swellings, the walls of which are of stony hardness, occur close together on opposite sides of the artery." Arterial disease, though not common in the animals in confinement in the Gardens, cannot be said to be rare, whereas in wild animals this disease is generally considered to be very rare. Perhaps an interesting parallel may be drawn in this respect between man under civilised conditions and animals in confinement. In the former arterial disease is of course common, but there is considerable evidence against its occurrence among certain people but just emerging from the Stone Age.

*Gastric Ulcer.*—The experience of this and last year seems to show that if gastric ulcers are not entirely confined to the Carnivora and Marsupialia, they are at least most common in these orders, since of a total of nine cases four occurred in Carnivora and five in Marsupialia. A young Ocelot (*Felis pardalis*) presented the lesions of this disease in a particularly interesting form. On opening the belly, part of the colon looked darker than usual, and it was found that this and the rectum were full of dark semi-digested blood; there were many small recent hæmorrhages in the stomach, over some of these the mucosa was destroyed but the ulcers had not penetrated deeply. In the duodenum there were, however, sixteen orifices, all more or less circular, and varying in size from that of the head of a large pin to that of a threepenny-bit. One of the largest of these extended

\* P. Z. S. 1906, p. 634.

as deeply as the serous coat, the others were less deep and involved only the mucosa and a part of the muscular walls of the gut. The Marsupials with gastric ulcer were all herbivorous.

*Perforation of the Uterus.*—An instance of this unusual accident occurred in a bitch of the North-African Jackal (*Canis anthus*). The mammary glands betokened recent activity, and on opening the abdomen the uterus projected well above the pelvis; there was general peritonitis and the uterus itself was dark and intensely congested. Within it lay a dead and extremely offensive foetus, while a small circular perforation existed in the uterine wall just above the cervix on the left side, and it was apparently due to leakage through this hole that peritonitis had set in.

*New Growths.*—The rarity of new growths referred to in last year's note is confirmed by this year's post-mortem examinations on a larger number of animals. Only four cases occurred; two of these, both in mammals, were carcinomata and presented no unusual features; but the third case, a Bear, had multiple small angiomas of the liver, none bigger than a sixpenny-bit, which cannot have exerted any evil effect on the health of the animal.

The last case occurred in a Chilian Pintail (*Dafila spinicauda*) alleged to have been bred in the menagerie and to be 26 years old. On opening the bird a mass the size of a turkey's egg was seen occupying the right flank in the front of the belly; it was not adherent to the intestine or other organs but was enclosed within a thin, loose capsule resembling peritoneum within which, with the mass, were the supra renals, which were not affected. The mass could not be traced to any organ, but seemed to arise at the root of the mesentery; no testes could be found, although the trachea was of the normal male type; there was a white mass about the size of a filbert in the right lobe of the liver, and both kidneys were whitish and much enlarged. Microscopically it was seen that the main mass was structurally a carcinoma, as was that in the liver, and both these masses resembled the much enlarged kidneys which were themselves carcinomatous.

My thanks are due to Mr. S. G. Shattock for the diagnosis of this remarkable case, which it seems must be classed as an example of diffuse carcinomatous growth in both kidneys with secondary masses in the liver and glands at the root of the mesentery.

While considering the occurrence of new growths in birds, allusion may be made to two very interesting conditions which have recently come under my notice. The subject of the first of these was a domestic fowl belonging to Dr. R. N. Salaman\* which died suddenly. On opening the belly cavity this was found to be full of blood, and the liver was found to be diffusely angiomas. The second condition occurred in a Sparrow examined by Dr. A. Wilson\* in the course of certain physiological work. On opening the skull a spherical mass about the size of a pea was seen

\* My thanks are due also to these gentlemen for allowing me to refer to their specimens.

to press upon the right half of the cerebellum, which it had to some extent excavated. This mass was enclosed in a sheath of pia mater continuous with that over the posterior part of the right cerebral hemisphere. Dr. Wilson thought that the spherical mass might at one time have been joined to the cerebral hemisphere, but of this there was no direct evidence. Microscopically the tumour mass contains true nerve-cells, and so is an example of an extremely rare condition.

### 3. On a peculiarly Abnormal Specimen of Turbot.

By J. T. CUNNINGHAM, M.A., F.Z.S.

[Received January 23, 1907.]

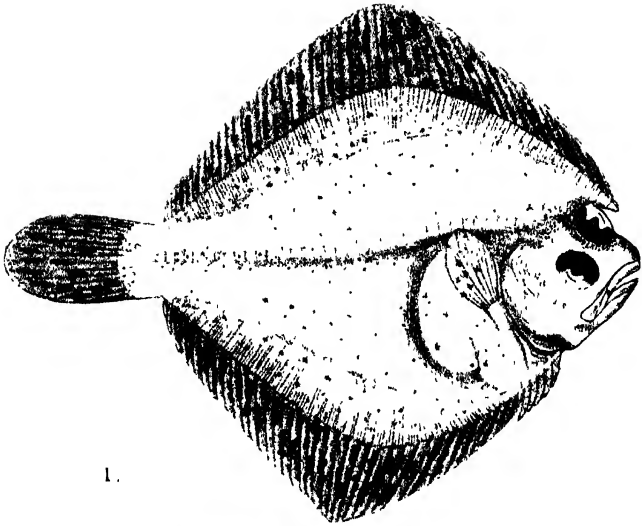
(Plate XI.\*)

The specimen here described was sent to me by Dr. E. J. Allen, Director of the Marine Biological Laboratory, Plymouth, in the beginning of December 1906, with a request that I should examine and describe it. With the fish was a normal specimen and two letters referring to them—one from Mr. John D. Enys, the other from Miss Olivia L. Fox. Mr. Enys' letter is dated Nov. 3, 1906, and states that Miss Fox had then alive in a glass globe two small Turbot caught on the sands at Polzeth, near the Doom Bar at Padstow, on the north coast of Cornwall; that the abnormal fish was dark on the under side and white on the upper. Miss Fox's letter states that she had had the fish about a month, and that the upper side "was becoming pigmented" since she first obtained it.

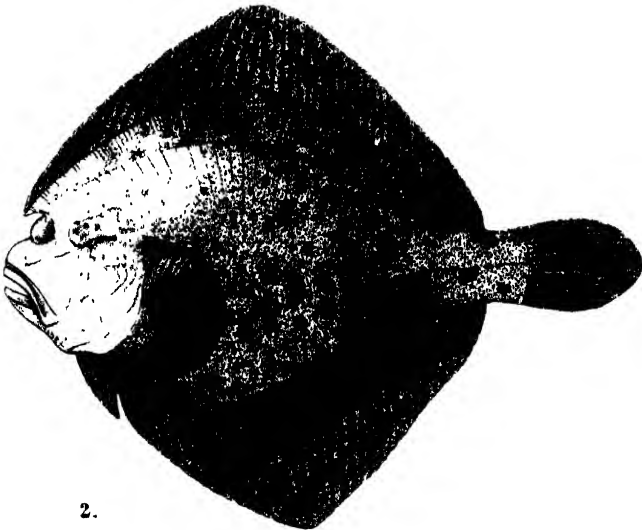
The specimen is 4.4 cm. in length and presents a condition which, so far as I am aware, has never previously been observed or described in flat-fish of any species. With respect to the position of the eyes, the fish is a reversed specimen—that is to say, both eyes are on the right side, whereas normally in Turbot they are on the left. With respect to colour, on the contrary the specimen partially resembles a normal Turbot. The right side is almost entirely unpigmented; the greater part of the left side is coloured like a normal Turbot. The pigmentation does not extend uniformly over the whole of the left side, but is absent from the head, and from the anterior part of the dorsal region above the head. On these areas there are only a few scattered black chromatophores. On the right or uncoloured side there are also scattered black chromatophores rather more numerous than on the left side of the head. It is important to note that the head and anterior region of the right side, although not fully pigmented, have more pigment than the rest of that side; between the eyes and around the dorsal eye pigmentation is almost complete.

The number of dorsal fin-rays in the specimen is 65, of the ventral 47. The characteristic tubercles of the adult Turbot are not yet developed, but there are three little projections at the base of each of the dorsal and ventral fin-rays, and also projections

\* For explanation of the Plate, see p. 181.



1.



2.



at the bases of the caudal and ventral rays. These are probably the beginnings of marginal tubercles.

The anterior end of the dorsal fin and the basal tissue which carries it form a projecting hook-like process over the dorsal eye -- that is, the originally left eye, which has moved to the right side of the head. This projection, due to the absence of attachment between the base of the fin at the anterior end and the head, occurs commonly in ambicolorate specimens of the turbot and less frequently in ambicolorate specimens of other species of *Pleuronectidae* (see Cunningham and MacMunn, "Coloration of Skins of Fishes, &c.," Phil. Trans. 1894).

A letter from Miss Fox to Dr. Allen, dated Jan. 7, 1907, explains that the fish was caught on Sept. 28 last year, and lived in captivity till Nov. 28, when it died from some unknown cause. When caught it was, unlike all the others seen at the same time, quite stationary on the sand, which Miss Fox thought might imply a certain blindness. In captivity, however, it was very active, and certainly saw food very quickly, so that there is no reason to think the function of the eyes was affected.

In Plate XI. I have figured the two sides of the abnormal specimen. The normal specimen was 4.2 cm. long. Its metamorphosis is complete, but there are still a few scattered black chromatophores on the right or lower side. Similar black chromatophores are present on the right side of the abnormal specimen, and they appear to be larger and slightly more numerous; but the difference is slight, so that the exposure of the right side to light during the two months it was in captivity had not produced much effect.

It seems to me that the only way to attempt an explanation of the condition of this specimen is to base the explanation on the view of the constitution of the ovum which was developed by Weismann, and which is adopted in the Mendelian doctrine of heredity. If the right side of the anterior or cephalic region were more completely pigmented, we might regard the fish as consisting of an anterior smaller part which was reversed, and a posterior part which was normal. The condition would then be explained by supposing the specimen developed from an ovum consisting of parts usually occurring in separate ova. We know that reversed specimens occur in various species of flat-fishes, *e. g.* the Flounder (*Pleuronectes flesus*). In this species in some localities reversed specimens are not only common, but abundant. At Plymouth I found about 30 per cent. of the specimens captured had the eyes and pigment on the left side instead of on the right. It is necessary here to consider the precise terms to be used to indicate the structural peculiarities which present themselves. It has been usual to speak of a Flounder with eyes on the left side as reversed; but if we use the substantive corresponding to this adjective, namely reversion, we are using a term which has been employed in an entirely different sense, namely as meaning atavism, or the recurrence in a species of some more or less remote ancestral form.

It is true we might use the word reversal, but this is not sufficiently distinct. In order to avoid confusion it will be better to coin a new term, and it seems to me the most appropriate term is "metastrophe," meaning a change in the direction of the turning. For adjectives we may use merely sinistral or dextral, referring to left or right side, or for the abnormal condition in general we may use metastrophic.

Since, then, metastrophe frequently occurs in flat-fishes, and is a congenital abnormality due to some abnormality in the constitution of the ovum, it is intelligible that it should occur in one part of a fish and not in another. We may suppose the abnormality in the whole fish is due to the interchange of position in the ovum of the parts corresponding to the left and right sides of the body. The abnormality does not, however, affect the viscera, which, as I have pointed out in the memoir already cited, are constant in position whether the fish is dextral or sinistral. In the particular specimen of Turbot which we are considering, the head is dextral, or metastrophic, the posterior portion normally sinistral, and its origin is to be attributed to a corresponding abnormality in the constitution of the ovum from which the fish was developed.

With regard to the question of the origin of such abnormalities in the ovum, they may arise either in the cell-divisions which occur in the multiplication of ova or spermatozoa of gametes, to use the general term, or in the process of fertilisation, the conjugation of the gametes. It might be suggested in this particular case that the condition was due to a "cross" between an abnormal dextral specimen and a normal sinistral specimen, the condition of the head-region being inherited from one parent and that of the posterior region from another. But metastrophic or dextral specimens are, so far as my experience goes, rare in the Turbot, and it seems equally possible that the peculiar condition of the gamete which gave rise to the abnormality was not due to the condition of one of the parents.

It is not necessary to suppose that both of the gametes which produced the fertilised ovum were abnormal: abnormality in one only may have been sufficient to produce the abnormality of development. In the division of the gametes within the reproductive organ of a parent fish, the chromosomes of the nucleus, which are supposed to be the "carriers of heredity" or to contain the "determinants" which produce the characters of the organism to which the gamete gives rise, normally divide severally so that two similar ova are produced. In the final or reduction division each chromosome does not divide, but the group of chromosomes separates into two groups. In one or other of these divisions the determinants might be displaced, so that either all or some of those belonging to the left side were on the right and *vice versa*, and thus a metastrophic gamete would be produced.

One important question that arises from the condition observed in the specimen under discussion is, what bearing it has on the experiments carried out by me some years ago at the Plymouth

Laboratory, and described in the paper already cited. In those experiments pigment was developed on the lower sides of Flounders as a result of the incidence of light. Here we have a specimen of Turbot in which the upper side is exposed to light and is not pigmented, while the lower side is pigmented. But it must be noted that no adult specimen has been observed in which this condition occurs. According to Miss Fox's letter quoted above, the upper side of this young turbot had already acquired some pigment during the two months in which it lived in her possession. It is quite possible therefore that if the specimen had lived to become adult, the upper or right side would have become fully pigmented in consequence of the action of light, and then the specimen would have been exactly similar to other ambicolorate specimens of Turbot, except that it was metastrophic, the eyes being on the right side instead of the left.

In my experiments, I showed that when young fish in process of metamorphosis were placed in the apparatus so that light fell on the lower side and not on the upper, the normal hereditary changes were not arrested, pigment disappeared from the lower side as under normal conditions, and it was only later, after long exposure to light, that pigment was developed on the lower side. Thus, as the specimen we are here considering had not long passed its metamorphosis, there is nothing inconsistent with my results in the absence of pigment from the right side, although that side is uppermost and had been exposed to light for a short time.

The condition of the specimen here described suggests that the usual ambicolorate abnormality is due also to partial metastrophe, but that in these cases the *anterior* part of the body is normal or sinistral, and the *posterior* part dextral. This view would explain the remarkable fact, of which hitherto no explanation has been given, that in the great majority of ambicolorate Turbot the lower or right side of the head is unpigmented, just as in the specimen here described the left side of the head is unpigmented. The limits of the pigmentation are not absolutely constant. In the majority of specimens which I have seen, the pigmentation extends on to the lower jaw and the anterior end of the dorsal fin, while the rest of the head in front of the preopercular bone is unpigmented. One specimen in my list, however, had pigmentation over the whole of the lower side, including the head. If the explanation suggested is correct, it follows that the young of an ambicolorate specimen immediately after metamorphosis is without pigment on the postcephalic portion of the upper or left side, and that it becomes ambicolorate in adult life in consequence of the development of pigment on that side under the influence of light. There is at present no direct evidence of this beyond the occurrence of the specimen described in this paper, and the question must be further investigated by the examination of large numbers of young specimens. When pigmentation extends over the whole of the lower side, including the head, it cannot be said that the head of the fish is normally asymmetrical; therefore the theory of



partial metastrophe does not apply. In this case we must conclude that some other explanation is to be sought, or we may suppose that the boundaries between the determinant groups in the ovum are not definite, and that the pigment determinants displaced to the right side have extended to the head-region.

It may be objected that the persistence of colour on the lower side of an ambicolorate Turbot is inconsistent with my views of the action of light, that if pigment were produced on the upper side it ought to disappear from the side turned to the ground. This objection is of little weight, for my experiments show that it is easier by means of light to produce some pigment where it was previously absent, than to abolish it when it is present, by cutting off the light. This is what might be expected, for in the evolution of a flat-fish pigment has only recently disappeared from the lower side, in consequence, as I believe, of the absence of light; and therefore the pigmentless condition is not very strongly inherited, and pigment is produced after a comparatively short exposure to light. The positive character on the other hand, the presence of pigment, has existed not only since the flat-fish was evolved, but in a long line of ancestors before that, and therefore it would probably take several generations to cause the pigment to disappear completely by cutting off the light. It is quite possible that when the lower side is congenitally pigmented, some proportion of the pigment is lost in consequence of the absence of light, but such a loss would not be obvious to observation and would be difficult to demonstrate. Obviously a small amount of pigment appearing where there was none before is evident at once, but the disappearance of a small proportion from a strongly pigmented surface makes no apparent difference to the colour, and there is no means of measuring the amount of pigment for comparison in different cases. There can be no doubt concerning the presence of a single sheep in a field, but it is much more difficult to decide whether there are a thousand or 999 in a flock.

It has long been known that in *Pleuronectidae* generally, and especially in *Rhombus maximus*, there is a marked correlation between ambicoloration and the malformation of the dorsal fin which occurs in the specimen described in this paper. It seems to be generally supposed that in such specimens the dislocated eye has not completed its change of position, and being on the edge of the head instead of on the upper side, prevents the usual growth forwards of the base of the dorsal fin. The condition is regarded then as, like the ambicoloration, a reversion on the part of the eyes and skull towards the primitive symmetry. Although I have not fully investigated the structure anatomically, it is my opinion, from external observation, that the eyes and skull are normal and that the peculiarity is merely due to a want of that attachment which normally occurs between the base of the fin and the skull, along the united ectethmoid or prefrontal, and frontal bones. The view I have suggested seems to me to give a better explanation of this abnormality than has hitherto been proposed. If the head

is metastrophic and the posterior region normal, as in the specimen here described, or *vice versa*, as in ambicolorate specimens previously described, then the normal relation of the determinants of these parts in the ovum, and therefore in development, is wanting. The anterior end of the dorsal fin belongs to the posterior of the two portions abnormally joined in the fish. It tends to grow forward, but in the normal case in doing so unites with the right side of the skull (in the Turbot); whereas in the abnormal specimen here described, where the head is metastrophic, it has the left side of the skull opposite to it, and with this side it has no congenital relations, and so remains separate from it. In the more usual case, where the eyes are on the left side as usual but the fish is ambicolorate, a similar explanation would apply. Here the right side of the skull is opposite the fin, as in the normal fish; but the fin being itself metastrophic, the normal relations between fin and skull in development are disturbed, and consequently they remain separate. It may be said in fact that in all these cases the fish, or the ovum from which it develops, is composed of two separate parts united in an abnormal relation to one another in a plane transverse to the long axis of the fish. Consequently the normal continuity between the head and body is, as it were, imperfect; and in all probability this is the real reason why in these cases the anterior end of the dorsal fin remains unattached to the head.

The abnormality of the dorsal fin does not occur in specimens which are entirely metastrophic. Here, although the characters of the right side develop on the left, and *vice versa*—that is to say, the determinants of the right and left sides have changed places—the dislocation of determinants in the gamete has taken place along the median plane, and therefore the longitudinal continuity between fin and skull is not disturbed.

It is important to mention that the abnormality of the fin in the specimen here described is not merely due to incomplete metamorphosis. The normal specimen of the same size, or rather smaller, sent with the abnormal, and captured at the same time, shows complete metamorphosis, and in it the dorsal fin extends forward attached to the head to a point anterior to the eyes.

The correlation between ambicoloration and the abnormality of the dorsal fin is not invariable. Cases occur in which ambicolorate specimens are in this respect structurally normal. In the Phil. Trans. memoir by myself and Dr. MacMunn (referred to above, p. 175), I made the generalisation from the specimens of Turbot then known to me, that if pigment was present over the whole of the body behind the pre-opercular bone, and also on the lower jaw and the anterior end of the dorsal fin, the malformation of the dorsal fin was present; whereas if the pigment was less than this, the malformation was absent. On the hypothesis of the cause which I have suggested, the absence of the malformation in the latter case is intelligible, for then the junction between the metastrophic and the normal parts of the body may be supposed to occur not between

the dorsal fin and the head, but in the course of the dorsal fin itself. The anterior end of the fin then belonging to the same part of the composite fish as the head, the relations of the two structures in development are not disturbed. Holt\*, however, records a specimen of Turbot in which there was some pigment on the lower side of the jaws and on other parts in front of the preoperculum, and yet the head and fin were structurally normal. This exception is not enough to disprove my hypothesis, for it may happen exceptionally that the two parts in the composite gamete are so exactly fitted together in their new relations, that the fin attaches itself to the skull in development as in a normal specimen.

The fact which gives most support to my hypothesis, is that in the great majority of ambicolorate Turbot the lower side of the head is white and destitute of pigment. The same condition has been seen by me in two specimens of *Pleuronectes macrocephalus* and one specimen of Plaice, *P. platessa*. In the Flounder (*P. flesus*), however, I have not found the absence of pigment from the lower side of the head in ambicolorate specimens. In the Phil. Trans. memoir I have recorded four specimens in which the lower side was completely coloured and in which the usual abnormality of the dorsal fin was present.

There is, however, another fact concerning ambicoloration which is difficult to reconcile with the view that it is due to the metastrophe of the posterior region, namely, that in ambicolorate specimens not merely both sides are pigmented, but both sides are equally armed—that is to say, the scales, spines, or tubercles are equally developed on both sides. In normal flat-fishes the armature is much reduced on the lower side. In the Turbot the scattered tubercles present on the upper side are almost entirely absent from the lower side; in the Flounder the rough spiny scales along the lateral line and along the bases of the dorsal and ventral fins are absent from the lower side. In ambicolorate specimens the armature is not only present on the lower side, but also on the upper; the abnormal specimens are not merely ambicolorate, but ambiarmate. If, according to the hypothesis I have suggested, the postcephalic region were metastrophic, the upper side should be originally not merely without pigment, but without armature, like the lower side in normal specimens. If the pigment on the upper side in ambicolorate specimens were due to light, the armature should remain absent, unless the action of light produces armature as well as pigment, for which there seems no reason and for which we have no evidence. Something might be attributed to the absence of friction from the upper side, but this is excluded by the strong development of the armature on the lower side in these abnormal specimens. These considerations are in favour of the alternative hypothesis to explain ambicoloration and ambiarmature, namely, that in the gamete two right or two left sides are united instead of a right and left. In this case of course all

\* E. W. L. Holt, "Studies in Teleostean Morphology from the Marine Laboratory at Cleithorpes," P. Z. S. 1894, p. 413.

the characters of the upper side would be reproduced in the lower, both pigmentation and armature. The symmetry does not extend to the eyes and skull, but then the malformation of the head may be due to a partial symmetry, a reduction of the normal asymmetry.

It is possible that both cases occur in different specimens—that is to say, that in some ambicolorate specimens the condition is due to metastrophe of the posterior region of the body; in others to secondary symmetry, the doubling of the upper side in the gamete. This cannot be decided without further investigation of abnormal specimens both in the young state and the adult. There can be no doubt of the importance of the unique condition exhibited by the specimen here described, or that its condition is best explained on the view I have suggested, namely, that it consists of a metastrophic head joined to a normal body.

I beg to offer my thanks and congratulations to Miss Fox and Mr. Enys for making the specimen known, and my thanks to Dr. Allen for allowing me to describe it.

#### EXPLANATION OF PLATE XI.

##### Abnormal Young Turbot.

Fig. 1. Right (upper) side of abnormal Turbot 4½ mm. long, enlarged. The eyes are on the right side of the head, and the dorsal fin projects anteriorly as a free process. Some pigment on the head dorsally, elsewhere only scattered black chromatophores.

Fig. 2. Left (lower) side of the abnormal Turbot shown in fig. 1. No eyes on the left side of head, nor pigment. Pigment on the posterior region as in normal specimen.

#### 4. On the Azygos Veins in the Mammalia. By FRANK E. BEDDARD, M.A. (Oxon.), F.R.S., Prosector to the Society.

[Received February 1, 1907.]

(Text-figures 62-73.)

#### CONTENTS.

- |   |   |
|---|---|
| (1) Introductory, p. 181.                     | (9) The Azygos and other thoracic veins in the young of <i>Myopotamus coypu</i> , p. 213. |
| (2) The Azygos Veins in the Ungulata, p. 183. | (10) The condition of the Azygos and the Classification of Mammals, p. 218.               |
| (3) Insectivora, p. 196.                      | (11) The position of the Azygos with reference to the Vertebrae, p. 219.                  |
| (4) Lemurs and Apes, p. 197.                  | (12) The Veins Intercostales Supremæ, p. 221.   |
| (5) Edentata, p. 198.                         | (13) Conclusions, p. 222.   |
| (6) Carnivora, p. 198.                        |   |
| (7) Marsupials, p. 200.                       |   |
| (8) Rodents, p. 208.                          |   |

#### (1) Introductory.

It appeared to Cuvier\*—and presumably to his editor Duvernoy, since the statement is left unannotated—that the Azygos veins in mammals were too variable to offer zoological characters of value;

\* Anat. Comp. ed. 2, t. vi. (Paris, 1839) p. 238.

for he wrote, "L'insertion de l'*azygos*, l'existence d'une *azygos* du côté gauche sont assez variables; mais on sait que les mêmes circonstances varient dans l'homme. Elles ne méritent pas conséquemment de nous arrêter." Milne-Edwards\*, on the other hand, and rightly, treats these veins as of importance, and tabulated the main variations. These statements really express the main facts as we know them today. With reference to the Marsupials, indeed, the assertion of Milne-Edwards seems to me to be nearer to the truth than some generalisations made more recently. This group is placed by Milne-Edwards under the heading "Les deux veines *azygos* également développées." Although I shall show reasons for slightly criticising this statement, it is not greatly exaggerated. On the other hand, in denying the existence of a right *azygos* ("Point de veine *azygos* à droite") in the Sheep, Ox, Goat, Chevrotain, Pig, and Tapir he is, in my opinion, not by any means so accurate. With regard to the Tapir there is some error in Milne-Edwards's statement; for he also places that animal under the heading of those animals which only possess a right *azygos*. Sir Richard Owen's classical text-book, published ten years later than the volume of Milne-Edwards's great work, adds but little to the record of facts concerning the *azygos* veins. There are, however, numerous scattered references to the condition of these veins in various mammals by Owen and others, to some of which I am able to refer in the course of the following pages.

Many of these papers are quoted by Hochstetter† in his memoir dealing with the development of the *Azygos* (and other veins) in the Mammalia. A large number, however, relate to the condition of the *azygos* in man, and I do not attempt here to follow up that very large subject. I limit myself to such other mammals as I have been able to dissect, in many of which the *azygos* has not been described. The classificatory importance of the *azygos* has been recognised by Dr. Max Weber‡, and there is no doubt that its conditions are often distinctive of genera or of whole orders of mammals. I propose, however, to deal with this matter after exposing the facts which I have gathered together by degrees during several years of intermittent work upon the subject, which is a larger collection of facts concerning this vein than has previously been brought together.

Opinion with regard to the morphological nature of the *azygos* veins has lately undergone some change. Until lately the prevalent view was that one or both of the postcardinals persisted as the *Azygos*, the *Hemiazygos*, or both. This view is embodied in diagrams in many text-books.

Of recent writers Messrs. Parker and Tozier§ appear to hold

\* Anat. et Phys. Comp. vol. iii. (Paris, 1858) pp. 505-508.

† Morph. Jahrb. xv. 1803, p. 642 &c. Milne-Edwards's *résumé* is largely based upon the observations of Bardeleben (Arch. f. Anat. u. Phys. 1848) and Marshall ("Development of great Anterior Veins &c.," Phil. Trans. 1850).

‡ Die Säugetiere, Jena, 1904.

§ "Postcardinal Veins in Swine," Bull. Mus. Comp. Zool. vol. xxxi. 1896, p. 133.

much the same view. For they remark that in the Pig "the hemiazygos" (which is the left azygos of my nomenclature) "from the region of the heart to the tenth rib is therefore to be regarded as the persistent anterior portion of the left postcardinal." The rest of the vein is formed, as they think, from "the accessory veins," which appear to be the subcardinals of McClure\*. They thus agree with Rathke in holding that the anterior part of the azygos is persistent postcardinal, but differ from him as to the mode of formation of the posterior region of the azygos; for Rathke held that this region was due to a continual longitudinal anastomosis between intercostal veins, and was thus an entirely new structure. Zumstein† put forward the older view also in the case of man, where that anatomist believed that he had traced the azygos and the hemiazygos to the postcardinals exclusively. In the Guinea-pig, however, he‡ found that the postcardinals took practically no share in the formation of the azygos. Hochstetter§ came to conclusions which were not dissimilar. He allowed in the case of the Rabbit and of the Cat that the azygos of the adult down to about the eighth thoracic segment was the postcardinal, but that thereafter it was a new structure not formed from the postcardinal veins: "von da an caudalwärts aber ist sie eine Neubildung." This region of the postcardinal, in fact, becomes a part of the postcaval. A perfectly different origin of the azygos veins is asserted by McClure | of *Didelphys*. Excepting just at their entry into the duct of Cuvier they are quite independent of the postcardinals and of the subcardinals, though connected with the former by cross anastomoses. I shall bring forward various facts in the following pages which bear upon this question of the morphological nature of the azygos veins in mammals.

## (2) *The Azygos Veins in the UNGULATA.*

I have paid special attention to this group since I have particularly favourable opportunities, as compared with those enjoyed by other zoologists, of examining recently dead specimens. These bulky animals obviously cannot be preserved, and must therefore be studied immediately after death. It thus follows that I am able to add a good deal to what is known upon the subject. It will be seen, however, that there is a very general agreement among the Artiodactyle division of that Order as contrasting with the Perissodactyles, but that the division, as shown by the azygos vein, is not absolute. Max Weber, in his recent textbook (*Die Säugetiere*, p. 642), uses the condition of the azygos to define the Artiodactyla thus:—"Die Vena azygos fehlt; die

\* "Development of Veins of *Didelphys*," Amer. Journ. Anat. v. 1906, p. 163.

† "Entwicklung des Venensystems des Menschen," Anat.-Hefte, Bd. vi. 1896.

‡ "Venensystem bei dem Meerschweinchen," *ibid.* Bd. viii. 1897.

§ *Loc. cit.* p. 574.

|| *Loc. cit.* p. 185.

Vena hemiazygos mündet direkt oder indirekt in die Vorkammer." But, as I shall show, this is not quite universal.

Since the system of azygos veins is as perfect in the Gnu, *Connorchætes gnu*, as in any other Ungulata, and more elaborately developed than in many, I shall commence with a description of those veins in this Antelope. The anterior vena cava receives a right and a left azygos vein which enter it very nearly, if not exactly, opposite to each other. Of these two the right is rather longer than the left. This right azygos receives five branches, of which the most anterior is composed of affluents from two ribs. It is evident therefore that the right azygos does not reach back nearly as far as the diaphragm. The left vein is composed of only four intercostal branches. The blood from the ribs lying behind these four are connected, however, into another longitudinal trunk lying on the left side. Seven or eight of these branches coming from as many intercostal spaces combine to form a vein running in the same straight line as the left azygos, but not joining it anteriorly. The vein, in fact, opens independently into the right auricle, as previous observers have noted for other Ungulates.

It is not a little remarkable that the other species of Gnu, viz. *Connorchætes taurinus*, which I have also dissected, shows differences in respect of these veins from *Connorchætes gnu*. On the right side the azygos is a trifle smaller and collects blood only from four intercostal spaces. On the left side the azygos is very much longer, with seven or eight affluents. It enters the vena cava superior as in Marsupials &c., which possess two azygos veins. I did not detect any branch putting this vein into direct communication with the right auricle, such as occurs in *Connorchætes gnu* and in some other forms which I shall deal with immediately. An intermediate condition is offered by another Antelope, *Bulalis caama*. In this animal the right azygos is composed of five affluents. On the left side we have both the anterior and the posterior vein of *Connorchætes gnu*, and, as in that animal, the latter communication with the auricle direct. But a slender twig connects the two veins, which are thus a continuous vessel as in *Connorchætes taurinus*.

The azygos veins of *Rhaphiceros melanotis* present the usual Antilopine characters; but there are differences of detail from those of some other forms. On the right side, the internal mammary vein is followed in passing towards the heart by a superior intercostal which divides into two branches, each of which supplies the first or the second intercostal space. Behind this arises the right azygos, which is composed of three affluents; the first lies in the intercostal space  $2/3$ , the others in  $3/4$  and  $4/5$ . Thus the intercostal space  $2/3$  has two veins. On the left side there is a superior intercostal opening exactly opposite to the right-hand vein; but it is a larger vessel though it only draws blood from two intercostal spaces. The left azygos, as in allied forms, is well developed and enters the heart in common with the vena cava

inferior. It does not, however, consist only of a region lying behind its point of entrance into the auricle; but a branch also runs forward supplying four intercostal spaces, the first being that between ribs 2/3. The vein does not join the superior intercostal. But it will be noted that rib interspace 2/3 has on the right two veins.

*Ourebia nigricaudata* is much like *Rhaphicernus*. The vena cava anterior receives a pair of veins, the superior intercostals, which bring back blood from the region of the first rib only. The two veins are not absolutely symmetrical as to their point of entrance into the vena cava. The second to the fifth rib inclusive supply four intercostals which unite to form the right azygos. On the left side of the body the azygos consists of an anterior and a posterior section which unite at their communication with the right auricle. The anterior vein is very slender, excepting in the region at and near to its fusion with the posterior vein. The azygos proper, i. e. the posterior section, is a stout well-developed vein which receives blood from the intercostals on both sides of the body. It ends at the diaphragm in a bifurcation formed by the two intercostals supplying the last (the thirteenth) ribs.

*Cephalophus grimmii* showed an identity of arrangement in two examples, one a male, the other a female. The better developed left azygos entered the heart in company with the vena cava inferior, and not by a separate orifice. On the right side of the body the azygos consisted certainly of four intercostal affluents. The last two of these (at any rate in the male example) encircled the fourth rib. *C. maxwelli* shows much the same relation to *C. grimmii* that the two species of Gnu show. For the left azygos opens into the precaval. But it gives off a branch to the auricle.

*Oryx leucoryx* has also a comparatively short right azygos composed, however, certainly of five intercostal branches. The longer left azygos enters the heart either directly or with the vena cava inferior. Above the influx of the right azygos is a single inferior intercostal on the right side of the body, and on the left side a corresponding vein which, however, immediately divides into two trunks. There was, however, no connection between the posterior of these two veins and the lower section of the azygos system.

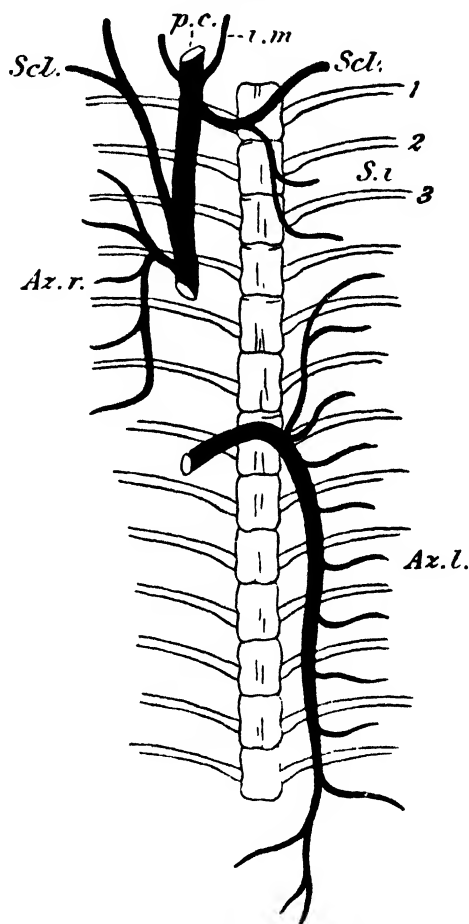
The arrangement of these veins is much the same in *Oryx beatrix* as it is in *Oryx leucoryx*. The left and principal azygos commences with the interspace between ribs 6 and 5. Above this is a *vena suprema intercostalis*, composed of only two branches lying in the first two rib interspaces. To this corresponds exactly on the right side a vein which draws blood only from the first intercostal space. Behind this the right azygos opens into the precaval opposite to the second or third rib. Its branches extend back to the sixth rib, and they begin with the second intercostal space.

I have selected for figuring here (text-fig. 62) the azygos and immediately related veins of *Cervicapra bohor*, on account of their splendid condition in the male example which I had the opportunity



of dissecting in the month of December of last year. I am pretty certain that I have been able to note down the characters of all the veins of this system in the present species. The animal, I may remark, was young and very slightly diseased. *Cervicapra bohor* agrees in essentials with other Antelopes; but there are differences

Text-fig. 62.

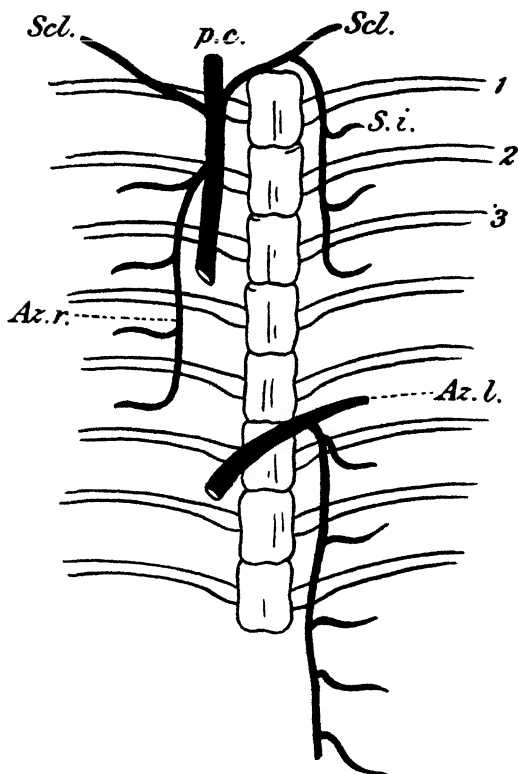
Azygos veins of *Cervicapra bohor*.

*Az.l.* Left azygos; *Az.r.* Right azygos; *i.m.* Internal mammary; *Scl.* Subclavian; *S.i.* Superior intercostal; *p.c.* Precaval. First three ribs numbered 1, 2, 3.

of detail which are worth recording. The main azygos trunk lies as usual on the left side and opens into the heart. The level at which it bends towards the heart is opposite to the seventh rib.

Its affluents, however, commence on the posterior side of the fourth rib. Beyond the last pair of affluents, which lie behind the thirteenth (and last) rib, the trunk is continued back as a very slender vessel. The first intercostal artery which crosses this azygos lies behind the tenth rib. Anteriorly, the second and third intercostal spaces give rise to vessels which unite into a trunk which debouches into the left subclavian vein. The right

Text-fig. 63.

Azygos veins of *Gazella cucuore*. Lettering as in text-fig. 62.

subclavian, it may be remarked, joins the precava quite a considerable distance behind the opening of the left subclavian—a marked asymmetry which is not common. It receives, however, no branches from intercostal spaces and enters the thoracic cavity in the usual position—that is, in front of the first rib. The right azygos is of fair size; it enters the precava about opposite the fourth rib. It receives branches from intercostal spaces 2 to 6 (inclusive).

In *Gazella euchore* (the example dissected was a male) the disposition of the several veins of the azygos system was as follows and as is shown in the accompanying illustration (text-fig. 63). The illustration in question shows that the subclavian veins are symmetrical with each other and occupy the usual position, emerging as they do in front of the first rib. To the left subclavian is attached the corresponding *vena intercostalis suprema*. This vein collects blood from the second and third intercostal spaces. I am not absolutely certain whether its longitudinal trunk is not continuous with the left azygos. The latter commences with a branch from behind the fifth rib; it enters the heart on a level with the sixth or seventh rib. The right azygos is fairly well developed and enters the precaval vein on a level with the second rib. It collects blood by branches from the second to the fifth intercostal spaces inclusive.

In a female *Capra megaceros* the left azygos also opened directly into the auricle; its first branch arose from behind the sixth rib. Anteriorly, a superior intercostal consisted of two branches lying respectively between ribs 1 and 2 and 2 and 3. On the opposite side a vessel corresponded exactly to this in point of entrance into the precava, but drew blood only from the first intercostal space. Immediately behind this opens the right azygos, which is made up of four intercostal branches from ribs 2 to 5. In another example, also a female, the azygos was also on both sides, but the right vein was smaller than in the specimen just described and only drew blood from two intercostal spaces.

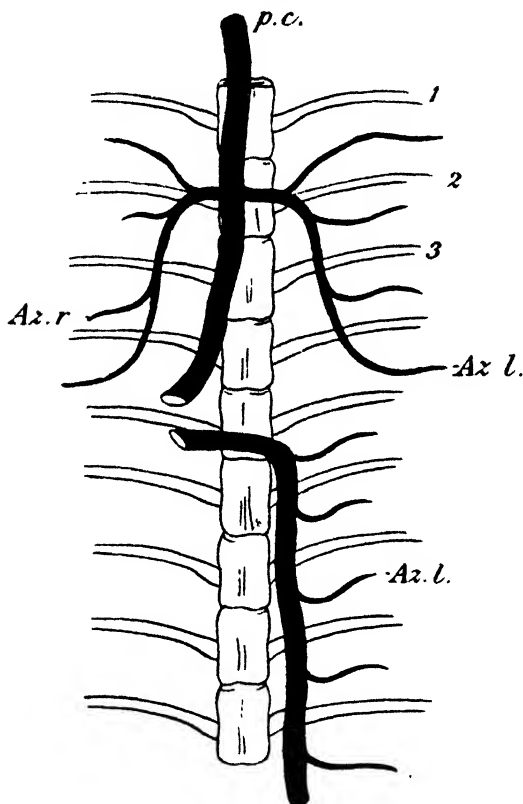
*Hemitragus jemlaica* ( $\sigma$  juv.) is rather different in the arrangement of these various veins. There is, on the left side, the typical Artiodactyl azygos entering the heart directly and commencing with a branch in intercostal space 4/5. There is no superior intercostal on this side; and on the right side there is only a single vein and that corresponds to the superior intercostal, since it draws blood only from behind the second rib.

Of *Nemorhardus swettenhami* I have dissected a single male example. As usual, the left azygos was the predominant vein concerned with the intercostal circulation. It receives branches from the fifth rib onwards, and the main trunk was traced some way into the lumbar region behind the last (*i. e.* the thirteenth) rib. The vena cava anterior receives the right azygos and a corresponding vein exactly opposite to it on the left side. The former receives blood from the first six ribs and ends entirely at the level of the sixth rib. The corresponding vein of the left side has naturally fewer branches and ends at the fourth rib. I did not ascertain whether there was any connection between the anterior and posterior series of intercostal veins on the left side of the body.

In an old example of *Phacochærus æthiopicus* (text-fig. 64) the azygos veins were rather different from those of the two species just described. The general plan was the same: that is, there is a long azygos vein on the left side. This vein started with an

affluent from the intercostal space between ribs 5 and 6. As far as the twelfth rib the vein lay outside the intercostal arteries, which up to this point passed between the azygos vein and the vertebral centra. The intercostal artery arising from the aorta between the twelfth and thirteenth ribs passed to the outside of the azygos. As a rule among mammals this point, where the azygos changes its position relatively to the intercostal arteries, is further

Text-fig. 64.

Azygos veins of *Phacocharus ethiopicus*. Lettering as in text-fig. 62.

forward. Anteriorly the precaval vein receives two quite symmetrically disposed veins, one from each side of the body, which convey blood from the more anterior intercostal spaces. These veins, moreover, are not only symmetrical with each other in so far as regards their point of junction with the precava: they draw blood from exactly the same intercostal spaces. Each consists of

four branches supplying the first four ribs. Their point of opening is about opposite the second rib.

In a young example of the African Red River-Hog (*Potamochoerus africanus*) the azygos was also limited to the left side of the body, as in *Porcula salvania*. In *Potamochoerus*, however, this vein enters the heart as in Ungulates; while in *Porcula* it seems to have the relations of the azygos in Marsupials &c., where a left azygos is present. The difference is not really of great importance as indicative of an anomaly in one or the other of these two genera of Suidæ; for we have in other Ungulates - e. g., in *Connorchætes gnu* - a left azygos which is divided into two parts whereof one opens into the jugular and the other into the heart. One or other arrangement is found in each of the Suine genera *Porcula* and *Potamochoerus*. *Potamochoerus* shows the arrangement which was found in *Sus scrofa* by Hunter\* and quoted by Owen in his 'Comparative Anatomy'† in dealing with the azygos veins of mammals.

In the Pygmy Hog (*Porcula salvania*) the azygos vein is only developed upon the left side of the body; there was absolutely no trace of this vein that I could discover upon the right side. It is large and thick, and its branches are important and obvious with the exception of the first. This more slender branch divides on issuing from the main trunk into three twigs, of which two run on each side of a rib. After this there are seven branches, which are large and were turgid with blood in the individual examined. These branches correspond of course regularly to the ribs; but they supply eight intercostal spaces, since the last of them, in which the azygos ends, bifurcates over its rib. The azygos lies very definitely upon the left side of the aorta; it is not median in position as is so often the case with this vein. The vein ended in front of the diaphragm; nor could I detect any branch, however thin, which continued on the main trunk behind the diaphragm in the direction of lumbar veins or of the postcaval or renal veins. These observations refer to one example only, which was a female.

The Musk Deer (*Moschus moschiferus*) presents us with a system of azygos veins like those of other Ungulates. On the left side the well-developed azygos enters the auricle directly. On the right side the small azygos consists of one vein only. In front of this, and on both sides of the body, is a superior intercostal.

*Dorcatherium aquaticum* did not show, as might perhaps have been expected, an arrangement of a specially primitive character. It is much like other Ungulates. There is a small azygos on the right side of the body formed by three affluents only. The azygos of the left side only communicates with the right auricle. It is as extensive as is usual among Ungulates and consists of many intercostal affluents. The first of these branches is made up of two tributaries. There is no anteriorly running

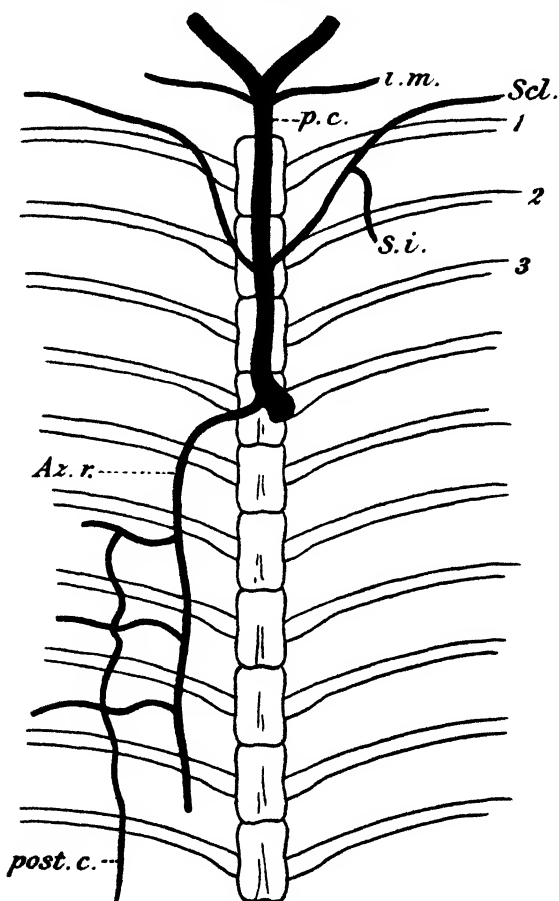
\* 'Essays and Observations on Natural History &c.,' arranged by Richard Owen, vol. ii. 1861, p. 124.

† Vol. iii. 1868, p. 555.

extension of this vein such as occurs in, for example, *Rhaphicerus*. It is interesting to note that *Dorcatherium* does not agree with its nearest ally, *Tragulus*, as the following account of the latter genus will show.

Of *Tragulus meminna* (text-fig. 65) I have been able to examine two adults—one of each sex—and a young one, nearly ready for

Text-fig. 65.

Azygos veins of *Tragulus meminna*.

*post. c.* Remains of posterior cardinal of right side (?).  
Other letters as in text-fig. 62.

lirth, taken out of the uterus of the female. In all three the azygos was present only on the right side and entered the precaval very near to the heart. The nearness to the heart seemed to me

to be more marked in the two adults than in the foetus. In the male adult the first affluent of the azygos arose behind the fourth rib; after this there was a gap of one rib, and three very much stouter affluents arose behind the sixth, seventh, and eighth ribs respectively. Thereafter the psoas muscles concealed the intercostal veins at their entry into the azygos, but they appeared to be regular. In the female Deer the same very stout intercostal veins arose from the intercostal spaces 6-7, 7-8, 8-9 as in the male, but I did not find the slender anterior intercostal which I have described in the male; I should not like, however, to assert that it was absent. It is very interesting to observe this constancy in a vein which has been stigmatised as most inconstant. Moreover, the foetus showed the same arrangement of these veins with a slight difference. The first affluent of the azygos was very stout and arose between ribs 3 and 4, being thus a rib further forward; but after this the first affluent of the regular series arose in the same way as in the two specimens of *Tragulus meminna* just described, behind the sixth rib. In this foetus, moreover, a very slender intercostal, which I did not find in either of the adults, arose from behind the second rib and either joined the precaval independently or just at the point of entrance of the azygos. In this foetus the first rib sent an intercostal vein to the subclavian of the right side. On the left side none of the three specimens had any properly developed azygos. But in the foetus and the male adult a large œsophageal vein received intercostal affluents from the second and third ribs on the left side and entered the subclavian of that side. There was something to correspond in the female; but I am unable to give a proper description. In any case, the presence of rather more veins in the foetus and the absence of at any rate much variation in the azygos system of the adult *Tragulus meminna*\*, are noteworthy. It is possible indeed that there was no variation at all.

There is a very considerable agreement between the azygos vein of *Tragulus* and that of *Cervus sika*, but not, as will be shown presently, of *Cervus aristotelis*. In a female of *Cervus sika* the azygos was developed only upon the right side of the body. There were no traces of anything of the kind on the left side. The right azygos enters the precaval rather forward in fact, opposite to the second or third rib. The first affluent which joins the azygos runs parallel

\* An interesting note upon certain points in the venous system of this Deerlet ("The Postcava of an adult Indian Chevrotain, *Tragulus meminna* Erxleben," *Anat. Anz.* Bd. xxix. 1906, p. 375), by Prof. McClure, has come into my hands through the kindness of the author during the writing of the present memoir. In this note it is remarked that, contrary to what is found in most mammals, but agreeing with the conditions observable in *Dasybus*, *Elephas*, and the Marsupials (generally), the postrenal division of the postcava lies directly ventrally to the aorta, instead of dorsally and to one side. Dr. McClure naturally wonders if this is characteristic of *Tragulus meminna*, or is abnormal. I looked into the matter carefully in the three specimens upon which I have reported above, and find that Dr. McClure has discovered a perfectly normal character of this primitive Ruminant. I may furthermore point out that he figures (*loc. cit.* fig. 2) the right renal vein as double and the left as being single as well as much longer. I found this also to be the case in the adult male and in the foetal male, but not in the adult female.

with it for some little distance as a longitudinal trunk, and receives branches from the second to the fifth intercostal spaces inclusive. The main trunk of the azygos commences with an affluent from the sixth intercostal space. There is, it will be observed, an obvious likeness here to certain Rodents also; for instance, *Cælogenys* \*. I may also observe that the vein lettered *post.c.* in text-fig. 65 also probably corresponds to this additional azygos, for the nature of which see p. 213 below.

In *Cervus aristotelis* the azygos on the right side of the body pours blood into the single precaval from five affluents, which collect blood from the first five intercostal spaces. On the left side there is a corresponding vein which, however, flows into the precaval rather in front of the right azygos, between the second and third ribs. This collects blood from the first and a few subsequent intercostal spaces. I think that it is continuous with the usual Artiodactyle left azygos, which enters the heart opposite to the sixth rib and extends back to the diaphragm.

Of Perissodactyle Ungulates I have only examined *Equus chapmani*. The arrangement here was precisely as in the Horse. The azygos was present upon the right side only. The first affluent contributing to the vein arose from the interspace between the fifth and sixth ribs, and the vessel appeared to end posteriorly after the affluent from the thirteenth rib.

*Hyrax capensis*.—This animal shows affinities to the Ungulates in the structure of the azygos veins combined with a good many differences from such Ungulates as I have been able to examine. It is noteworthy that this "Subungulate" agrees with the Horse and *Tragulus* rather than with most Artiodactyles in the much greater size of the right azygos. In view of other comparisons that have been made between *Hyrax* and the Perissodactyle Ungulates, this additional fact is of interest. In the Rhinoceros, according to Owen †, the right azygos is the principal azygos. This feature alone is, however, obviously not enough to establish an affinity with the Perissodactyle section of the Ungulata, for many mammals possess only the right azygos, with or without traces of the left. It is the characters of the azygos on the left side which indicate the Ungulate affinities of this animal. In one of two examples of *Hyrax capensis* which I have dissected, the first two costal interspaces were occupied by veins which united to form a single trunk opening into the vena cava anterior. These represent the superior intercostal vein of other mammals. On the right side of the body the corresponding veins were present, but each opened separately into the vena cava. The next two ribs on the left side, i. e. Nos. 3 and 4, were supplied by a vein each, the two veins lying both of them in the same intercostal space, between ribs 3 and 4. These united to form a slender trunk which passed backwards

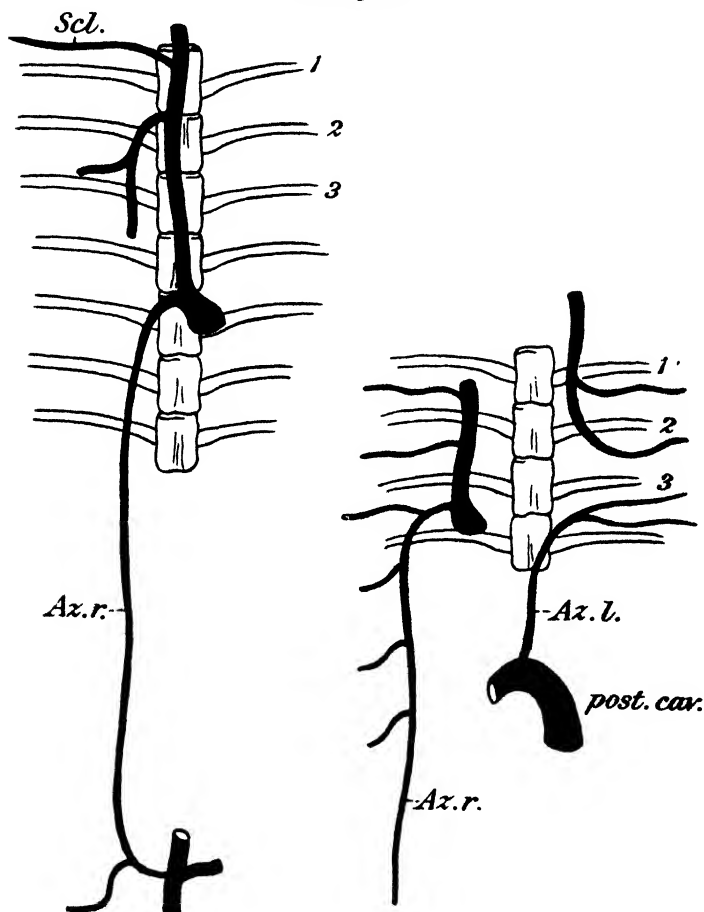
\* See p. 209.

† "On the Anatomy of the Indian Rhinoceros," Trans. Z. S. iv. p. 46. The Tapir also has been stated to possess a large right azygos.



and opened into the vena cava inferior (text-fig. 66) just before the debouchment of the latter into the right auricle. This is clearly the Artiodactyle condition of the vein in question, though differing in detail from that of any particular Artiodactyle that has been studied and described. For in that group there is either

Text-fig. 66.



*Hyrax capensis*; two different arrangements of azygos system.

*post.cav.* Postcaval. Other letters as in text-fig. 62.

an anterior and a posterior branch of the left azygos which unite close to the opening into the auricle or vena cava posterior, or the posterior branch alone is present. In *Hyrax* it is the anterior branch alone which is present.

The corresponding ribs on the right side were supplied with veins joining the long right azygos. The azygos system of *Hyrax* has been partly described by Brandt\* in a memoir upon the general anatomy of *Hyrax*, who observes that the vena cava posterior enters the right auricle "nachdem sie die vorderen *Venæ intercostales* und die *Vena azygos* aufgenommen." The same fact, according to Weber †, has been also noted by George ‡; but I have not had the opportunity of studying this paper §. Nothing is said by Brandt concerning the right azygos. It is, I presume, legitimate to compare the descending region of the left azygos in *Hyrax* with the left anterior cava. In a second specimen I did not find a left azygos opening into the vena cava inferior. But I am not inclined to deny its existence. The large right azygos was equally well developed in this example.

In a third example of *Hyrax capensis* (a female) the azygos system was entirely developed upon the right side of the body, and differed considerably from that of the two individuals just described. The main azygos stem (text-fig. 66) was traceable to the lumbar region, where it communicated with the vena cava inferior (not opposite to the renal vein) in common with a lumbar vein. The vein undoubtedly belongs to the right side since it lies on the trachea on the right side of that tube. Its mode of termination anteriorly is, so far as my own experience goes, unusual among mammals. Instead of entering the jugular some little distance in front of the heart, as is elsewhere (so far as I have seen in my own dissections) invariably the case with the right azygos when present, it enters that vein so near to its entry into the auricle that it may almost be said to enter the auricle separately ¶. But there is, of course, no question as to a direct communication with the coronary sinus, like the left azygos of the Cavicornia. In front of this vein, which debouches into the heart opposite to the fifth rib, is a small vein which receives blood from the 2nd and 3rd intercostal spaces.

The disposition of the azygos veins in the Artiodactyle Ungulates seems, therefore, to be fairly constant in the group, though the left azygos does not quite invariably open directly into the right auricle or into the vena cava posterior just before the opening of the latter into the right auricle. This arrangement of the left azygos has not been found in any other group of mammals excepting only in the Mole, where it has been stated to be the same as in the Artiodactyles. Possibly this fact may be considered as requiring confirmation. It is, however, interesting to note that as an abnormality the left azygos in man may open into the right auricle directly. I have not attempted to compare

\* Mém. Ac. St. Pétersbourg, ser. 7, t. xiv. p. 65.

† Die Säugetiere, Jena, 1804.

‡ Bibl. École Hautes-Études, Sec. Sc. Nat. xii. 1875.

§ In an earlier paper by George (Ann. Sci. Nat. (6) i. 1874) a right azygos only is described.

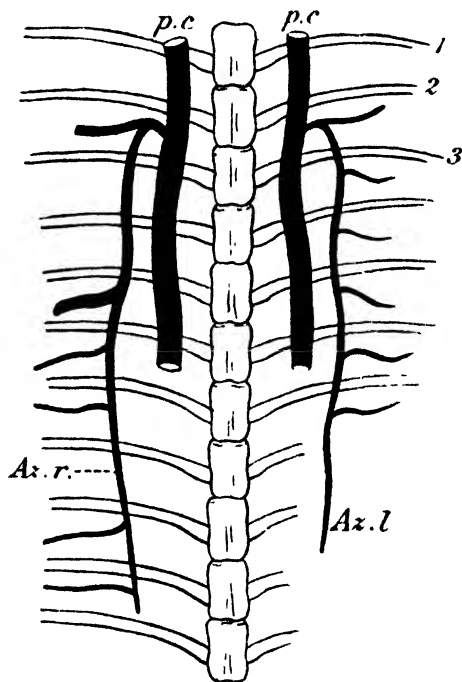
¶ This is also the case with the Horse, according to Chauveau and Arloing. I have also described the same arrangement in *Tragulus*.

the variations in the human subject with the conditions which are normal in other mammals, and it is possible that many examples have been recorded of this particular abnormality in man. I refer only to one instance, which I cull from the list of literature given by Hochstetter in his memoir upon the development of the veins in mammals\*.

### (3) INSECTIVORA.

My notes upon this group are very few, but not without interest. Milne-Edwards has observed † that the Mole possesses both azygos veins, and that the left debouches into the right

Text-fig. 67.



Azygos veins of *Erinaceus algerus*. Lettering as in text-fig. 62.

auricle precisely as in certain Ungulates. This fact is not referred to by Owen, who however states ‡ that "the left vena azygos communicates with the left precaval in the Hedgehog and many

\* Gruber, "Ueber einen Fall von Einmündung der V. hemiazygos in das Atrium dextrum cordis beim Menschen," Arch. f. Anat. u. Phys. 1864, p. 720.

† Anat. et Phys. Comp. iii. 1868, p. 595.

‡ Comp. Anat. & Phys. Vertebrates, vol. iii. 1868, p. 553.

others [of the "Lissencephala"], and is larger than the right." This does not exactly agree with what I have found in an example of *Erinaceus algirus*, ♀. Two azygos veins were present (text-fig. 67) and of equal length. Each opened into the precaval of its own side at a point corresponding to the interval between the second and third ribs. In the case of the right azygos, the first affluent arising between the second and third ribs and the second arising between ribs 5 and 6 were particularly large. It is noteworthy that posteriorly there was also an irregularity in the branches of the azygos, one branch often serving two intercostal spaces. The specially thick affluents were not noticeable on the left azygos.

I have also dissected one example of the Common Hedgehog (*Erinaceus europæus*), which differs both from Owen's account of that species already referred to and from *Erinaceus algirus* as dissected by myself. In this Hedgehog the right azygos alone was well developed, and commenced with an affluent from the first rib space, opposite to which it entered the right precaval. On the left side a very small azygos was present consisting, so far as I could see, of only one branch arising from the first intercostal space. It joined the left precaval at a point apparently exactly opposite the right azygos.

#### (4) LEMURS and APES.

Of this group I have examined a considerable number of species, and in all of them the right azygos as a distinct vein is present, and alone present. I have found this to be the case in the following, viz. *Lemur catta* (3 examples), *L. mongoz*, *L. xanthomystax*, *L. macaco*, *L. albifrons*, *L. coronatus*, *L. varius*, *Nycticebus tardigradus* (3 examples), *Perodicticus potto*, *Galago crassicaudata*.

Although it is correct to say that there is only a right azygos in these Lemurs as a complete vein entering the vena cava anterior on its own side of the body, there are in a few forms traces of the left azygos-- of a hemiazygos. Thus in *Galago crassicaudata* there is a longitudinal trunk springing from the right azygos opposite to the 7th intercostal of the right side of the body. This vessel runs forward, receiving intercostals from the left side and finally enters the left subclavian. This vein is obviously the left superior intercostal of man, but is more extensive in *Galago* than in *Homo*. Furthermore, a posterior fragment of the same vein and not continuous with it is left in the shape of a longitudinal connection between the 8th and 9th intercostals of the same side of the body.

In *Lemur albifrons* I found a hemiazygos arising from the right azygos shortly after the origin of the first of its intercostal branches, which crossed to the left side and received the intercostal veins of that side of the body.

Of the higher Primates I have examined a considerable number of species, in all of which there is but one azygos, the right, with,

in cases, a left hemiazygos. I do not for the present give any details concerning the Monkeys and Anthropoid Apes.

### (5) EDENTATA.

Of this group of mammals I have only been able to examine a few of the South-American forms.

In the Great Anteater, *Myrmecophaga jubata*, there is only a right azygos, with no traces that I could discover of the left-hand vessel. As this statement refers to three examples, including both sexes, it is probably a statement of the normal state of affairs in this animal. In one example, at any rate (I have not notes on the others), the first affluent occupied the 4th intercostal space.

Of the small Anteater, *Tamandua tetradactyla*, I have examined but a single specimen, in which the conditions of the azygos were quite the same.

In two Armadillos, *Dasypus villosus* and *D. minutus*, the right azygos was also alone present. Hyrtl, in his account of the anatomy of *Chlamydomorphus*, only found, or at least only mentions, the right azygos. These facts afford an additional argument, though doubtless a small one, for the banding together of the American Edentates.

### (6) CARNIVORA.

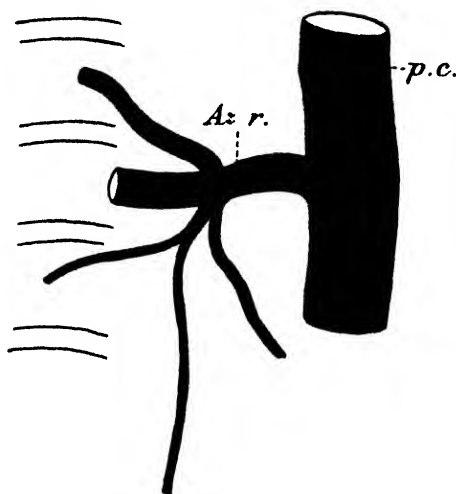
The azygos vein in this order of mammals presents a very uniform arrangement. I have dissected a considerable number of species belonging to many genera, and in the great majority of them there is but one azygos present, which is that belonging to the right side of the body. In these I have not been able to find any trace of the vessel of the left side. The following species present this condition of the azygos veins, viz.:—*Galictis barbara*, *Crossarchus obscurus*, *Cynictis leyaillanti*, *Viverra civetta* (2 examples), *Nandinia binotata*, *Cercoleptes caudirostratus* (3 examples), *Nasua rufa* (2 examples), *Felis pardus*, *Procyon cancrivorus* (3 examples), *P. lotor*, *Lutra vulgaris* (2 examples), *Helictes personata*, *Cryptoprocta feror*, *Herpestes griseus*, *H. pulverulentus*, *Arctogalidia trivirgata*, *Proteles cristatus*, *Gulo luscus*.

In two specimens of *Procyon cancrivorus* the azygos of the right side received a hemiazygos from the left side about halfway down, and there were no venæ intercostales supremæ. In *Procyon lotor* I found no hemiazygos, but there were two venæ intercostales superior on the right side, supplying the first two ribs and opening separately into the precava. On the left side a single vein opened into the subclavian.

The azygos vein in the Hyæna (*Hyæna crocuta*) (text-fig. 68) is the most remarkable modification of this vein which I observed in the Carnivora. As has been noted, the azygos in the Carnivora is constantly a long S-shaped vessel lying on the right side and extending down to the diaphragm, giving off regular branches. In

this *Hyæna*, however, the azygos is singularly short, supplying only three intercostal spaces. It opens into the Ductus Cuvieri by a single stout branch; this is formed by the union of three branches which are of very unequal calibre. The most anterior of these is a moderately stout vein running slightly forward in direction. The middle vein of the three is very markedly the stouter. It plunges at once, after the shortest possible course, into the thickness of the parietes. The third branch is more slender than both the first and the second. It also has a very short course obliquely backwards, and is very soon lost in the parietes. It gives off one branch to the left side and a slender short main azygos. I could discover no vein upon the left side of the body. It is to be remarked that we have here an abortive azygos, the first branches, or perhaps branch, only being well represented. These collectively correspond, as I think, to the first branch of the azygos in some other forms, which is very frequently subdivided into two or even three branches.

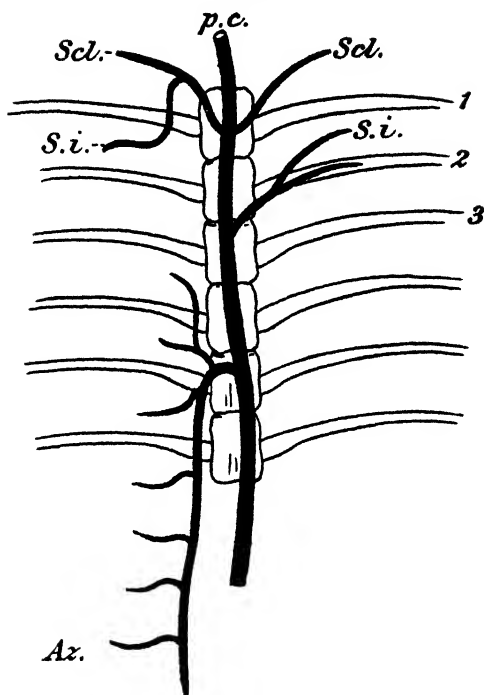
Text-fig. 68.

Azygos of *Hyæna crocuta*. Lettering as in text-fig. 62.

It is usual for the first branch of the azygos to arise between the fifth and sixth ribs in this order of mammals. I have found this to be so in *Procyon lotor*, *Lutra vulgaris* (one example; in another it arose between ribs 4 and 5), *Suricata tetradactyla*, *Genetta felina*.

In *Crossarchus obscurus* (text-fig. 69) the azygos entered the preceval about opposite to the fifth rib. Its most anterior affluent arose between the third and fourth ribs. Between the first and second ribs an intercostal arose on the same side (the right) and

Text-fig. 69.

Azygos of *Crossarchus obscurus*. Lettering as in text-fig. 62.

entered the subclavian vein. The corresponding vein of the left side of the body was formed of two affluents arising from the first two intercostal spaces, which opened into the precaval and *not* into the subclavian.

#### (7) MARSUPIALS.

I am able to give rather a fuller account of the genera of this group than of the other groups of mammals treated of in the present communication. And furthermore, of several genera which I have examined I have had the opportunity of seeing several species, and occasionally more than one example of the same species. The azygos veins of Marsupials have been lately the object of a careful study by Prof. McClure\* in connection with a detailed survey of the blood system of the Opossum, *Didelphys marsupialis*. He has in his memoir collected together what has been written upon the subject of this vein, and I shall review his conclusions in the light of the additional facts which I am here able to contribute to this branch of anatomy.

\* American Journ. Anat. ii. 1903, p. 371.

I shall commence with the Kangaroos, of which I have examined a good many different species.

In *Macropus ualabatus* the condition of the azygos veins is the most primitive of that to be seen in Marsupials. There are two veins, one on each side, each, of course, opening into its corresponding vena cava anterior. These veins appear to be exactly equal in length.

In *Macropus agilis* I have found one of the two opposite extremes. In the single example of this species which I have dissected there was but one azygos, lying upon the right side of the vertebral column. In the preceding species of *Macropus* the two azygos veins end, or at any rate dwindle to almost nothing, in the neighbourhood of the last rib behind the diaphragm. Their last affluent is derived from the body-wall close to the last rib. In the specimen of *Macropus agilis*, on the other hand, the single right azygos is continued as a wide vein for a long distance backwards. A little in front of the kidney it ceases to be superficial and is imbedded in the dorsal musculature. It then emerges and gives off a branch joining the vena cava posterior in the region of the kidney. This vessel is not the renal vein itself, for the latter can be followed from the kidney to the vena cava as a distinct and much thinner vessel. Behind this again the azygos dies away towards the pelvis, retaining till its extremity a considerable size.

In *Macropus melanops* I found in one individual the same state of affairs as in the last species in so far as only a single azygos was present, and that on the right side. This vein, however, was slender and drew blood from only six intercostal spaces, after which it dwindled or entirely disappeared. In a second specimen of the same species there was also a limited azygos on the right side; but, in addition to this, traces of one belonging to the left side of the body, which, however, was quite small and only drew blood from one intercostal space.

An example of *Macropus bruni* showed conditions intermediate between the two extremes already dealt with. In this species there was an azygos on the right side extending as far back as to the diaphragm. On the left side there was a less completely developed vein only drawing blood from four intercostal spaces.

A female *Macropus dorsalis* was not very different. In this Kangaroo the azygos was only properly developed upon the right side of the body. It was prolonged, however, for a long way back as in *Macropus agilis*. In the same way a branch was given off to the vena cava posterior underlying the renal vein. The azygos trunk ended some way behind this.

On the left side of the body there were traces of a left azygos. This consisted of the azygos proper, being a short vessel gathering blood from one intercostal space only, and of another trunk in front of this flowing separately into the vena cava anterior of that side of the body, which corresponds to the superior intercostal of other mammals.



A male *Macropus giganteus* showed an almost exactly similar arrangement of the several azygos veins. On the right side the vein was strongly developed and passed back to the pelvic region, giving off a branch to the vena cava posterior in the region of the kidney. On the left side one vein arose from the vena cava anterior sinistra which apparently corresponds to the two which arose separately in *Macropus dorsalis*. This vein was formed of two affluents only.

A female *Macropus rufus* possessed a well-developed azygos upon the right side, which however did not extend backwards to anywhere near the pelvic region. I traced it to the eleventh rib, between which and the tenth lay its terminal branch. The vein supplied all the intercostal spaces between this and the fifth anteriorly. On the left side of the body was a rudimentary azygos of two branches lying between the fourth, fifth, and sixth ribs. A second example, a male, showed an identical arrangement of both azygos veins.

*Macropus alligatoris* is precisely like *Macropus rufus*. In a male specimen of this Kangaroo the well developed azygos lay upon the right side of the body, while on the left side was a rudimentary vein formed of two affluents only.

Exactly the same description is to be given of *Macropus antilopinus*.

Of *Macropus derbianus* I have had the opportunity of seeing three individuals. Two of these were of particular interest since they were mother and daughter. The female fetus showed two azygos veins very nearly equal in extent, but the right was rather longer than the left; this discrepancy—it will be observed—being the usual one. On the other hand the parent showed reverse conditions; the left azygos was longer than the right, and in showing this character was unique among the examples of this genus which I have examined up to the present. But in a third specimen of the same species, adult and a male, the azygos veins were as nearly as possible equal, the left being again a trifle the longer.

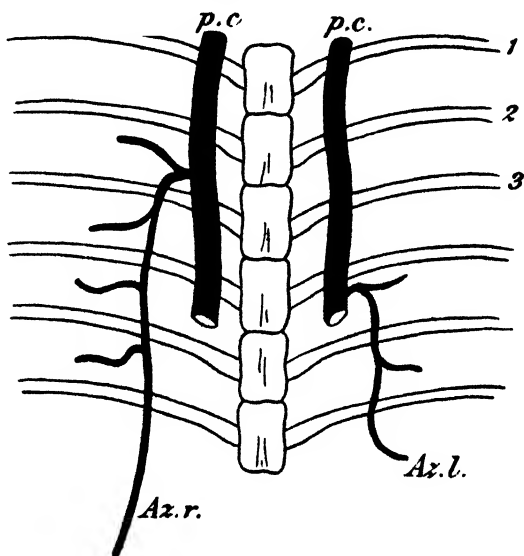
In *Halmaturus bennettii* I found the azygos on the left side to be distinctly longer than that of the right side. I counted in fact seven affluents on the left side. On the right side there were only five branches, of which the first followed the fifth rib. In a second specimen (text-fig. 70), a male just out of the pouch, the small left azygos had only three affluents from ribs 4 to 6. The right azygos began with an affluent from rib 2.

Of the genus *Dendrolagus* I have examined only one species, viz. *D. bennettii*. In this Tree-Kangaroo I found the azygos to be present only on the left side.

*Epyprymnus rufescens* is a species which shows differences in the proportions of the two azygos veins. In one example, a female the left azygos was shorter, composed of four affluents; the right reached to the diaphragm. In a male the right was very much the shorter, composed as it was of only two affluents. On the left side there were four or five branches before the vessel disappeared

into the thickness of the musculature. Later on this azygos dilated to form a thicker vessel which lay beneath the aorta and reached nearly to the iliacs. This is obviously quite comparable to what I have described above in *Macropus giganteus* and other species; but in them it was the right azygos which was thus prolonged and enlarged. I could not be certain whether in *Epyprymnus rufescens* there was or was not a connection with the renal vein or the postcaval. In this specimen there was also on the left side a superior intercostal vein flowing separately into the vena cava superior.

Text-fig. 70.

Azygos veins of *Halmaturus bennettii*. Lettering as in text-fig. 62.

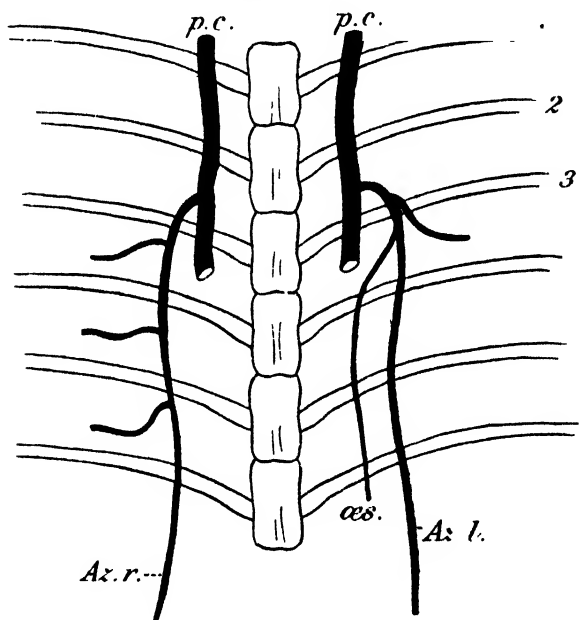
In a third example of *Epyprymnus rufescens*, which was a female, the conditions observed differed from those of either of the other two. The two azygos veins were absolutely symmetrical so far as I could see, and moreover this symmetry extended to quite small details. On both sides of the body the last two of the four intercostal affluents of each azygos joined before pouring their contents into the azygos. It is curious to find here in the same species all the chief varieties shown by the azygos.

While *Epyprymnus rufescens* is an example of a Marsupial in which the condition of the azygos veins varies from individual to individual, the Common Phalanger (*Trichosurus vulpecula*) offers precisely the reverse characteristic. Of this species I have dissected six examples belonging to both sexes. In all of them the azygos vein of the left side is fully developed and reaches back as far as the diaphragm. In all of them the right azygos is present

but is invariably small, and consists at the most of a short trunk made up of affluents from three intercostal spaces only. There is some difference in the exact number of these affluents; there are either two or three or apparently only one. In one example I recorded the further extension backwards of the left vena azygos till it reached the vena cava behind the kidney. This disposition of the azygos agrees with what has been already recorded by previous observers concerning this species. These previous observations refer to several examples. The state of affairs may therefore with confidence be regarded as characteristic of the species.

Allied to the Vulpine Phalanger is the Wombat (*Phascolomys mitchelli*) (text-fig. 71), of which I have dissected two examples from

Text-fig. 71.

Azygos veins of *Phascolomys mitchelli*.

oes. (Esophageal vein. Other letters as in text-fig. 62.

the present point of view. In the first example, a female, two azygos veins were present and about equalled each other in length. The conditions were in fact like those of *Macropus ualabatus*.

In a second Wombat, also a female, the conditions of the azygos veins were apparently identical. Both veins were present and well developed; but the right-hand one was the longer of the two. In front of the two azygos veins no intercostal

branches entered either of the two precavals. The right azygos entered the precaval at about on a level with the fourth rib. The first branch arose between the third and fourth ribs. The position of the opposite azygos was the same. The right azygos continued down to the tenth rib unaltered; at this point it divided into two branches, of which the outer supplied the intercostal spaces; the inner branch, which was more slender, received at least one cross branch from the outer and could be traced some little way back as a very slender vessel; I did not ascertain its posterior connections if any. Just after its bifurcation it was crossed by the first intercostal artery to cross it, those in front lying below the azygos. This division of the azygos posteriorly reminds us of the figure of the Pig's azygos given by Messrs. Parker and Tozier\*. But it seems more likely that the inner branch is not the hemiazygos, but possibly the subcardinal of the right side, the outer branch being in that case the true persistent postcardinal. These matters, however, are more fully dealt with below. The left azygos of this example of *Phascolomys mitchelli* was shorter than the right; it ended absolutely between the tenth and eleventh ribs.

In the Brush-tailed Rock-Wallaby (*Petrogale penicillata*) the disposition of the azygos veins was like that which is on the whole characteristic of the genus *Macropus*. I have dissected three examples, one male and two females. They all agreed except in minutiae. In all of them the right-hand azygos was the one to be well developed. But I never found that this vessel had a prominent backward prolongation to the pelvic region as is occasionally to be seen in *Macropus*. On the left side there is only a trace of the azygos, and this is either derived from only one or from two intercostal twigs. In *P. xanthopus*, according to Parsons†, the right azygos is also the larger, or rather the only one present.

I do not know whether it is necessary to separate *Bettongia penicillata* from *B. ogilbyi*. The condition of the azygos veins offers no help in deciding this question, since the two examples of *B. penicillata* differ considerably from each other, and I have only a single example which came into my hands labelled *Bettongia ogilbyi*. In one specimen of *Bettongia penicillata*, a female, the right azygos alone was well developed, extending far back towards or to the diaphragm. On the left side the azygos was very short, consisting of two intercostal affluents only. In the second example of this species, which was also a female, the azygos on both sides of the body was about equally developed. In the single *Bettongia ogilbyi* the two azygos veins were well developed; but that at the left side was distinctly the longer of the two. It is to be noted that if we are to unite these species, as Mr. Thomas has done in his 'Catalogue of Marsupials in the British Museum,' the differences exhibited in respect of the azygos vein are almost exactly the same as those shown by *Apyprymnus rufescens*.

\* Bull. Mus. Comp. Zool. xxxi. p. 138, fig. 4.

† See P. Z. S. 1896, p. 706.

In a single example of *Dromicia nana* the azygos was well developed on the left side of the body and there was a short azygos on the right side.

In a species of *Pseudochirus* the azygos was present on the left side only; in addition to the azygos an anterior intercostal flowed separately into the vena cava anterior, deriving its blood from a single intercostal space only. In a second example (*P. peregrinus*) I found the same. The azygos proper commences with the second rib and joins the vena cava in the neighbourhood of the left kidney.

A single male example of *Petaurus breviceps*, which was injected to illustrate the anatomical relations of these veins, possessed an azygos on the left side only.

In the Thylacine the left azygos is the predominant one, and there is also a left superior intercostal vein entering the precaval independently of the azygos. The right azygos is, however, by no means rudimentary for it supplies four intercostal spaces.

*Phascogale penicillata* has likewise a well-developed azygos on the left side extending back to the diaphragm. I saw none on the right side of the body.

In a female *Dasyurus viverrinus* the azygos veins were almost exactly like those of the Thylacine. The left-hand vein was well developed, extending back almost as far as the diaphragm; on the right the azygos was formed of five affluents. In a male *D. maugei* the left azygos was well developed and there was no trace of a right-hand vein.

A female *Perameles obesula* agreed with *Phascogale* rather than with the last species; for the azygos was present only on the left side of the body.

Of *Onychogale frenata* I have examined a single female example. The azygos was predominantly developed on the left side of the body. It flowed into the jugular at a point about opposite to the fifth rib. The first branch of this left azygos formed the intercostal vein lying between ribs 4 and 5. Thence regular branches were given off as usual. The main stem of the vein became much thinner in the region of the diaphragm; but thereafter increased notably in volume and could be traced back down into the pelvic region as a massive vein of not much smaller calibre than the vena cava, alongside and to the left side of which it ran to a point which I did not determine. There is an obvious similarity in this case to that of *Æpyprymnus rufescens* described above. The azygos was connected to the vena cava by a stout branch in the neighbourhood of the kidney. An anterior vein, the superior intercostal, arose separately from the left jugular and supplied ribs 3 and 4. There flowed into the right jugular at a point corresponding to that of the left azygos a much smaller right azygos. This slender vein only drew blood from ribs 4 to 7.

The results obtained from the dissections enumerated in the foregoing pages enable me to revise some of the conclusions arrived at by Dr. McClure in his memoir referred to above.

Dr. McClure is of opinion that "a single azygos vein is the rule in Marsupials, and that when two are present the case may be regarded as a variation." The facts gathered by myself seem to me to show that the double azygos of the Monotremata is largely preserved in the Marsupials, so much so that the process of disappearance of one or the other is but rarely completed. There are but few forms in which there is absolutely no vestige of either right or left azygos as the case may be. This is precisely what would be expected in view of the admittedly archaic position of the Marsupials, accepting, of course, the view now generally held that they are not intermediate between the Prototheria and the Placentals, but are an offshoot of an early Eutherian. For in the Rodents, an admittedly primitive type, we have considerable traces of the double azygos. This latter point, however, will be discussed in relation with the azygos in Mammalia generally on a subsequent page. On the other hand, my own observations confirm Dr. McClure when he remarks that a right azygos is characteristic of the genus *Macropus*, and that a left azygos is characteristic of the *Phalangeridae*.

I would rather extend Dr. McClure's remarks about the condition of the azygos vein in the Carnivorous Marsupials, and point out that in this whole group the existence of a prevalent left azygos is the rule so far as we know at present. The table given by Dr. McClure of the condition of the azygos in such Marsupials as were known when he wrote, brings out very clearly the variation in respect of the veins not merely from genus to genus but from species to species. This generalisation I confirm with great confidence, and also would emphasise the very frequent variation of these veins from individual to individual. The condition of the azygos in fact is by no means so fixed in this group as it is in the Carnivora, for example; and modification is evidently progressing along two lines, in one of which the right azygos and in the other the left azygos is being retained, while the opposite vein is in process of disappearance.

Noteworthy, too, is the occasional large size of the postdiaphragmatic continuation of the azygos in the Kangaroos, *Macropus giganteus*, *M. agilis*, &c., which is, so far as my own observations go, invariably of the right azygos.

The above results may be conveniently tabulated as follows:—

a. Azygos on both sides equal or nearly equal.

*Macropus ualabatus*, *M. bruni*, *M. derbianus*, *M. bennettii*, *Phascolumys mitchelli*, *Bettongia ogilbyi*, *Æpyprymnus rufescens*, *Thylacinus cynocephalus*, *Dasyurus viverrinus*.

b. Azygos large on right side, with a rudiment on left of not more than three intercostal affluents.

*Macropus dorsalis*, *M. giganteus*, *M. rufus*, *M. alligatoris*, *M. antilopinus*, *M. melanops*, *Petrogale penicillata*, *Bettongia penicillata*.

c. Azygos only present on right. No rudiment on left side.  
*Macropus melanotis*.

d. Azygos large on left side, with a rudiment only on right side.

*Trichosurus vulpecula*, *Dromicia nana*, *Ephyrymnus rufescens*,  
*Onychogale frenata*.

e. Azygos on left side only. No rudiment on right side.

*Dendrolagus bennettii*, *Didelphys nudicaudata*, *Pseudochirus*,  
*Perameles obesula*, *Petaurus breviceps*, *Phascogale penicillata*,  
*Dasyurus mauvei*.

# (8) RODENTS.

Of the azygos in this order of Mammalia Owen wrote that "opposite proportions [to those shown by the azygos veins of the Hedgehog] prevail in Leporidae and some other Rodents, as in Squirrels, the left azygos being small or wanting." This statement is largely but not entirely true, as will be seen in the course of the following description of several genera and species of Rodents. In view of the fact that so many Rodents possess, as is well known, both precaval veins, it might be expected that here, as among the Marsupials, where a like condition of the precaval exists, there would be traces of both right and left azygos. And this is precisely what is found among the Rodentia. It is for this reason that I treat of the Rodents next to the Marsupials.

The most remarkable condition of the azygos vein so far as concerns the Rodentia is seen in the *Bearer*. But as I have only had the opportunity of dissecting a single example of this Rodent, the structure may be abnormal in the individual. There is only a single azygos; but the vein, instead of lying upon the right side, as is otherwise the case when the vein in question is only developed upon one side of the body, lies upon the left side. This state of affairs is, however, only an exaggeration of that found in *Jaculus orientalis*. In this Rodent, as I have ascertained and shall point out, of the two azygos veins present that of the left side is the larger instead of, as in the majority of cases where there are two azygos and a discrepancy in size between them, the right being the larger.

This condition of the azygos, however, exists among the Marsupials, as has already been pointed out\*, and also among the Ungulates†, but apparently nowhere except as an anomaly.

Of *Capromys pilorides* I have had the opportunity of studying two examples which, although they present certain differences, agree in certain main features in which they also present unmistakable points of likeness to their allies *Hystrix* and *Dolichotis*.

The azygos is either only or almost entirely to be found on the right side‡. The vein on that side in one specimen follows after

\* *Supra*, p. 202.

† *Supra*, p. 190.

‡ Dobson (P. Z. S. 1884, p. 248) only mentions a left azygos.

an anterior branch from the right jugular. This latter branch divides soon after issuing from the jugular (to reverse for the convenience of description the direction of the blood-flow) into two, one anterior and the other posterior. Each of these supplies several intercostal spaces, the anterior two and the posterior three. The azygos proper does not branch until after it has passed the region supplied by the branch referred to. Its first twig supplies two intercostal spaces. The rest are single branches. On the left side of the body is a single vessel supplying only one space. In the other specimen I observed no branch on the left side of the body. On the right side the first branch of the azygos runs forward and supplies on each side of the body three intercostal spaces. It obviously corresponds to the anterior branch of the jugular of the last individual.

In *Caelogenys paca* I have observed rather different arrangements of these veins in two specimens. This animal, unlike *Dolichotis*, has two jugulars. In one individual (both were males) the azygos was developed on both sides of the body though considerably longer on the right. On this side of the body a branch is given off early in the course of the azygos which supplies several intercostal spaces; the main trunk of the vein runs of course parallel with this, and gives off no branches until the last of those supplied by the large branch referred to. In this specimen the inferior intercostal veins do not open independently into the jugular, but into the azygos before it communicates with the jugular. In the second individual both right and left superior intercostals were quite independent of the azygos of their side, entering each jugular separately. The azygos vein of the left side of the body although present was very slightly developed, apparently collecting blood from only one intercostal space.

In *Dolichotis patackonica* the conditions of the azygos were as follows:—The trunk of the right side is the chief one to be developed. It is, however, as in some other forms (e.g. *Macropus dorsalis*\*), derived from two branches which arise separately from the jugular. The first is a small branch which runs in a forward direction. The second trunk is the main azygos. This at once gives off a branch which divides into three twigs, the rest of the branches are single in their origin from the azygos. On the left side of the body a vein arises three or four ribs further forward. Before reaching the parietes it gives off a slender twig which runs backwards along the carotid and the aorta. I have not traced this vessel out to its end; it is evidently to be compared with a similar vessel in *Lemur macaco*. When it has reached the parietes this azygos divides into two vessels which run in the same straight line and are continuous fore and aft along the body-wall. Two intercostal veins arise from the anterior section and three from the posterior section. I did not detect any connection of this left-hand vessel with the subclavian vein anteriorly.

\* But in this case it is the left azygos which shows the peculiarity mentioned.



In another example of *Dolichotis patagonica*, the conditions observed were a little different. The azygos proper was only to be found on the right side of the body, in correspondence with the fact that this rodent has but one jugular vein. In front of the azygos are two separately arising superior intercostal veins. On the left side the vein described in the first specimen of *Dolichotis* also existed, but was of much more limited extent than in that individual. It corresponded in place of origin with the upper of the two separate superior intercostals of the right side. The vessel divided into two branches only, of which one was behind the point of emergence of the vein from the jugular. It is clear that this trunk is the same as that which in the other specimen takes up the place of the azygos of the left side of the body, though it is much less extensive. There is thus no essential difference in respect of the veins of the intercostal system between the two individuals. Only a difference of degree in the development of the same, and that a slight one.

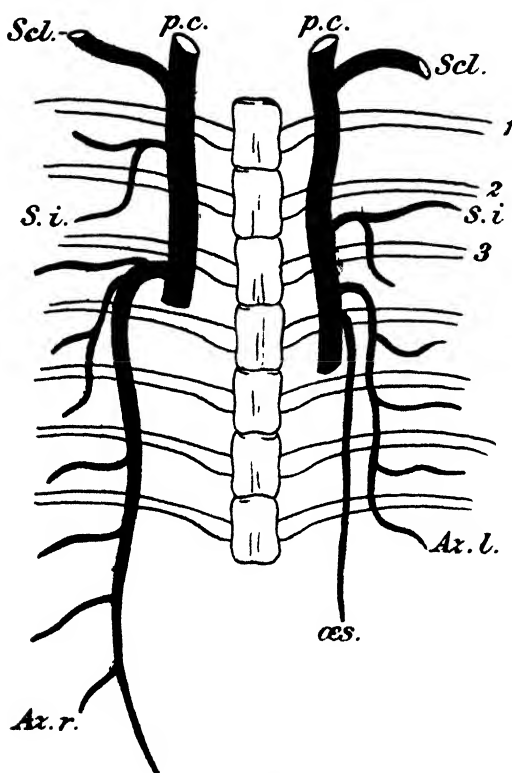
The Porcupine (*Hystrix cristata*), belonging as it does to the same subdivision of the Rodents as the Patagonian Cavy, naturally shows some resemblances to that rodent in the disposition of the azygos veins. The right-hand trunk is the chief one to be developed\*. In front of it, however, arise from the right jugular separately two intercostal veins. The main trunk gives off first a branch which supplies one rib. This is followed by a more important branch which supplies three intercostal spaces as does the corresponding vessel in *Dolichotis*. After this the branches are single. On the left side of the body the vena cava anterior sinistra (the left jugular) gives off two vessels following each other which arise at about the same level as the two branches of the right jugular which lie in front of the azygos proper. The second of these is the most important, and runs for some distance down the body, giving off four branches to the intercostal spaces. All these lie posteriorly: there is no forward continuation of the vein such as occurs in *Dolichotis*; but the forward extension of the vein in *Dolichotis* is evidently replaced in *Hystrix* by the separate twig arising from the left jugular.

In a second example of *Hystrix cristata*, a male, the arrangement of the azygos veins (text-fig. 72) was apparently identical. I use the word "apparently" because in the first example I did not count the ribs between which the various branches of the azygos ran. In the second specimen the azygos flowed into the right jugular at a point on a level with the interval between the third and fourth ribs. The first branch, exactly in the same way as in the example I have just described, supplied three intercostal spaces, beginning with the third rib. A superior intercostal vein arose from the jugular in front of this, and received from the first and second ribs a branch each. On the left side the azygos proper was very slender, but supplied ribs

\* Parsons (P. Z. S. 1894, p. 685) states that there is "only one azygos vein" in *Atherura africana*.

four to seven, and there was in the same way a superior intercostal. The constancy of the first branch of the azygos of the right side which supplies several branches is remarkable. It seems to me to be possible that this branch is the real post-cardinal, persistent here to a greater extent than in most other mammals which I have dissected. In any case its relations are perfectly consistent with such a view of its nature. I may mention that in this example I noted an œsophageal twig arising separately from the left jugular not in common with the azygos.

Text-fig. 72.

Azygos veins of *Hystrix cristata*.

œs. (Esophageal vein. Other letters as in text-fig. 62.

In the Canadian Porcupine, *Erethizon dorsatum*, the jugular, contrary to what is to be found in *Hystrix*, is a single vessel. The system of azygos veins is also single and confined to the right side of the body. There is no trace that I could discover of either azygos or superior intercostals on the left side. The

azygos presents no features of any special interest; it is like that of many other animals. In front are two separately arising superior intercostals. The difference between these veins in the present genus and in the true Old World Porcupines is one more justification of the absence of near affinity between those superficially similar rodents. I examined two specimens of this species.

*Myopotamus coypu* has two jugulars, and there is an azygos vein opening into each at the same level. That of the right side of the body is the one which is fully developed and runs a long way down the body. On the left side a slender twig joins the jugular of that side which appears to emerge from one intercostal space only. The arrangement of these vessels in the Chinchilla is the same.

In *Lepus europæus*, *Arctomys marmotta*, *Cynomys ludovicianus*, *Lagomys roylei*, there is but one azygos and that on the right side of the body.

In *Sciurus bicolor* there are also two jugular veins as in the species which have just been described. There is also in the same way but a single azygos vein arising from the right jugular. The branches of this vein are collected from the series of intercostal spaces commencing with that lying between ribs 4 and 5.

*Sciurus maximus* differs from the other Squirrel mentioned in the present communication in that there is but a single jugular vein, which is the right-hand one of other Squirrels. Into this opens the well-developed right azygos vein, which presents no differences from that of other members of the genus *Sciurus*, except of the smallest detail. Its affluents commence with that of intercostal space 5/6. Corresponding to this vein, however, there is a very small left azygos. This vein collects blood only from ribs 4 and 5, and it opens into the single jugular just a trifle in front of the point of opening of the large right azygos. The right azygos, I should add, in both the species that have just been referred to extends back considerably further than the last rib.

Of *Sciurus vulgaris* I have examined two individuals, one a male and the other a female. The two agreed in every detail of structure. This species belongs to that group of the rodents which possess two jugulars. But in spite of this the azygos vein is single and is present on the right side only. I did not observe any superior intercostal vein arising from the jugular in front of the point where the true azygos springs. I found the same to be the case with *Sciurus palmarum*.

In *Hydrochaerus capybara* there are similarly two jugulars and only a single azygos, which as in *Sciurus* is on the right side of the body. There was nothing to be seen of an azygos on the left side, which is perhaps remarkable in view of the relationships of this rodent. This statement moreover applies to two examples of the species.

In the Jerboa, *Jaculus orientalis*, a rodent with two jugulars

also, there are two azygos veins well developed. I have dissected two examples, both females, of this species, and find that in both the left azygos is rather the larger of the two, markedly so in one specimen. This is a curious reversal of the prevalent arrangement in Rodents and is reminiscent of conditions found among the Marsupials. So far as my experience goes this condition of the azygos veins is unique among the Rodents. It obviously culminates in the condition observable in the Beaver, where there is but a single azygos vein and that of the left side. Precisely the same series is to be met with among the Marsupials.

(9) *The Azygos and other Thoracic Veins in the Young of Myopotamus coypu, and the Homologies of the Azygos in Mammals.*

A recent examination of four young specimens of the South American *Myopotamus coypu* has furnished facts of great interest in connection with the real nature of the azygos veins in the Mammalia generally, besides making a contribution to the anatomy of these veins in that particular rodent. The four individuals were born dead, but apparently were of full time. They came into my hands on the following morning, and were in admirable condition for study. All four agreed excepting in one detail, and this apparent divergence may have been due to the difficulty in tracing the smaller branches of veins. In all of these examples there were three veins in the thoracic region, as well as—of course—the post-caval. Two veins (text-fig. 73) were symmetrical with each other, and lay on either side of the vertebral column near to the point of articulation of the ribs. Of these veins the right-hand one was constantly the larger. Both opened into the right and left anterior cava respectively. Branches arising intercostally were seen in both cases. In front of the point of entrance of this vein into the precava there were no representatives of the *venae intercostales supremæ*. That is to say, no veins to which this term might be applied opened separately into the precava. But as a matter of fact all the intercostal spaces from the very first backwards had their intercostal veins, which in the case of the anterior ones passed backwards to join the main trunk. They joined the main trunk very nearly at its point of entrance into the precaval vein, and the slightest shifting of the posterior set of intercostals would divide the affluents of the precaval into two veins—an anterior, corresponding to the *vena intercostalis suprema*, and a posterior azygos. But is this vein to be considered an azygos? This point may be deferred until after description of the third thoracic vein. This vein was rather larger than either of the paired veins just considered. It lay in each case on the right side, or—to speak more accurately—it poured its contents into the precava on the right and not into the left-hand one of those veins, paired here as in many other Rodents. The vein really lay rather medianly in position, running over the centra of the vertebrae. Anteriorly it joined

the vein of its side which has just been described and opened in common with it into the precava.

In one at any rate of the Rodents this vein bent distinctly to the right before effecting this connection, and in another there was the same bend and (see text-fig. 73) a slender straight vessel continued on the direction of the vein and apparently opened into the paired vein rather nearer to the precava. It was generally to be seen—possibly invariably present though hard to see owing to deficiencies in the blood—that this vein was connected by cross vessels with both of the paired vessels already described as running

Text-fig. 73.



Lateral view of the thoracic region of newly-born *Myopotamus coypu*, dissected to show azygos vein (*Az.r.*) and persistent postcardinal (*post.c.*).

alongside of the vertebral column on either side. I am inclined to think that these cross trunks were segmentally arranged in accordance with the vertebræ. This vessel was longer than either of the paired trunks, and posteriorly the last cross anastomosis that I observed on the right side was continuous with a longitudinal vessel obviously continuing on the paired vessel of its side, though a break occurred between the two. This trunk, receiving affluents in the lumbar region, ended by opening into the postcava near to the entry into the same of the right renal vein. Anteriorly the unpaired vessel lay outside the area which would be occupied by the intercostal arteries (though I did not

actually observe the arteries here); later on it could be distinctly seen to lie within that area. The intercostal arteries could be observed to lie outside of the vein. We can now consider what is the nature of those several veins. There seem to me to be only three possible views, one of which is so improbable that it may be shortly considered first of all and then dismissed. This view is that the paired vessels are two azygos veins which have been formed in a way not indicated in the specimens from the postcardinals, and that the single more median vein represents the esophageal branch which is at least very commonly developed from the azygos and often leaves it near to its connection with the precaval. If this is the case the vessel must degenerate very much in maturity, and its numerous cross connections with the paired veins are not easy to understand. It seems in fact unlikely that such unimportant vessels as the visceral branches of the azygos should have so portentous a beginning and so impotent a conclusion. The other alternatives are mutually exclusive. Either the paired veins are the postcardinals and the unpaired vein is a single azygos, or the single vein is the one remaining postcardinal and the paired veins are azygos veins which have been derived from that and another vanished postcardinal. The first of these views seems to me to be fairly obviously the correct one; and for the following reasons. In the first place, paired postcardinals and an unpaired azygos are more likely than the reverse. This is, of course, not conclusive, for one *ex hypothesi* postcardinal might have disappeared. Secondly, the presumed azygos corresponds with the adult *Myopotamus* where there is only one azygos, and, as is so general with the azygos, it lies partly outside and partly inside the intercostal arteries. The median position too of the presumed azygos is like that of undoubted azygos veins, while the lateral position of the presumed postcardinals is again in consonance with that view of their nature. In the next place, Dr. McClure\* has pointed out that the azygos arises from the postcardinal in the Opossum to the median side of that vein, which is precisely the position occupied by the presumed azygos in the young *Myopotamus*. Furthermore, the break between the thoracic and the abdominal regions of the paired veins is in accord with the view that they really are the postcardinals; for such a break has been described in the course of the development of those veins.

It is obvious that these facts throw some light upon the azygos veins in general. It seems highly probable that we shall have to distinguish in future between real azygos veins or vein and persistent postcardinals. It is even possible that the true azygos vein is always a single vein, and that when there are apparently two—one on each side—it is a case either of both postcardinals persisting or of a single azygos with one persistent postcardinal. That there should be such large differences even in allied mammals seems surprising; but it is by no means impossible even on

\* *Loc.cit.* (see p. 183).

*a priori* grounds, if - that is to say - we are permitted to use the analogy of the development of the postcaval. It is perfectly clear from developmental facts that in the Marsupials generally that vein has a different origin posteriorly from that which it has in the Rabbit, while McClure appears to have shown that in different individuals of *Didelphys marsupialis* the extreme end of that vein originates differently. In man, according to the facts collected by Hochstetter, the postcaval has as a variation a different mode of origin from that which is normal.

In the young pouch-living individual of *Macropus derbianus* described above\*, it was pointed out that there were two azygos veins in both fœtus and parent. There was no trace in either that I noted of any other vein. It seems to me to be possible that in that and other Marsupials there are not any azygos veins at all, but the persistent cardinals take their place. That this is not the case, however, in *Didelphys* appears to be shown by McClure's investigations†. Again, the relations of the azygos in *Cervus sika* described above‡ lead one to the inference that the anterior branch of the azygos running for some distance to the outside of the azygos is a remnant of the postcardinal of that side, since the junction of the two veins near to their entrance into the jugular recalls exactly the conditions which have been described above in the young *Myopotamus*. These remarks, however, cannot be considered at present as more than suggested possibilities. It seems to me to be equally likely that in those cases where a well-developed right azygos or left is accompanied by a less developed vein on the opposite side of the body which I have called azygos in the preceding pages, the latter is really a persistent postcardinal.

In addition to these there are cases where on one side of the body at any rate both azygos and postcardinal appear to persist. Those instances present as a permanent condition the state of affairs which occurs temporarily in *Myopotamus coypu*. In one of two *Celegenys paca* described above, there is, as I regard it, a well-developed persistent postcardinal on the right side and traces of the same on the left, in addition to a well-developed azygos on the right and a good but not so well-developed azygos on the left. In *Capromys pilorides* there are also considerable remains of the right postcardinal as well as of the right azygos. In *Hystrix cristata* (see text-fig. 72, p. 211) we see precisely the same thing on the right side; in this species in both examples dissected. *Dolichotis patagonica* has also, if my views are correct, both a right azygos and a short right postcardinal. Nor is this retention of a fetal condition peculiar to Rodents, though clearly, so far as my experience goes, most abundant in them; for it also occurs on the right side of the body in *Cervus sika*.

The relationship of the posterior end of the azygos to the postcardinal of the right side requires further emphasis. As has

\* *Supra*, p. 202.† *Loc. cit.* p. 183.‡ *Supra*, p. 192.

been mentioned, the azygos bends over the vertebral column and joins a vein running nearer to the ventral side of the body, which is hidden posteriorly by the kidney and opens into the postcaval near to the entry thereto of the renal vein. Previously to this the vein has collected tributaries from the lumbar body-wall. This is precisely what occurs in other and adult mammals. It is frequently the case that the azygos, after emitting the vein to the last intercostal space, curves in to the same way over the vertebral column and can be traced back to the kidney, in the neighbourhood of which it debouches into the postcaval vein. It seems to be clear, from the relations of the different sections of the veins concerned, that the bend to the right (of the right azygos) is the equivalent of one of the cross branches, by many of which the azygos is put into communication with the right postcardinal. Thus the complete azygos in such mammals is azygos *plus* one cross communication with the postcardinal *plus* the lumbar section of the postcardinal. The azygos, therefore, has as complex a formation as has the postcaval itself.

This condition of the azygos in many mammals contrasts with the conditions to be observed among the Marsupials. Here, as has been pointed out, it is not infrequent for one azygos, either right or left, to be a vein of very considerable importance, not merely in the thoracic region but also in the abdominal region. In various Diprotodont Marsupials, duly recorded in the preceding pages, I have found a thick vein in the kidney region, sometimes even extending further back, in fact quite into the pelvic region. This vein, which in the abdominal region runs parallel with the postcaval, is connected with that vein by an anastomosis. Further forwards it is directly continuous with the azygos vein of its side, which lies in or very nearly in the same straight line with it. Not unfrequently there is a thinning before the two veins meet, but still a continuity. This was seen for example in a specimen of *Epyprymnus rufescens*. In others there was no such thinning. These cases are, as it appears to me, to be best explained on the assumption that here the "azygos" of the adult is in reality the persistent postcardinal of its side. Hence the absence of the bend such as occurs in *Myopotamus coypu*. The thinning I put down to the "break" which has already been referred to as occurring between the thoracic and abdominal parts of the postcardinal in many mammals.

There are two other matters for consideration in view of this suggestion with reference to the differing nature of the azygos in the adult. Firstly, the variability of these veins becomes of a different aspect, since it is not one but two distinct veins or pairs of veins which vary. The actual variability is therefore reducible in consequence, and to be considered from different points of view. The variability in the proportions of the two azygos veins in the Diprotodont Marsupials is, if my suggestions be correct, obviously not the same thing as the variability in the two veins which bear the same name among the hollow-horned Ruminants.



Broadly speaking, it appears to me that the true azygos is by no means so variable a vein as are the persistent postcardinals, a conclusion which is in perfect accord with general principles. A partially persistent, though obviously decaying structure, is apt to vary more than a newer structure, which may be increasing rather than diminishing in importance. Thus we find that the true right azygos is very constant among the Carnivora. Secondly, there is the fact of the continuation into the abdominal region even as far as the pelvic region of the azygos vein. In some cases at any rate, possibly in the majority or even all those animals which (*e. g.* Carnivora) possess a true azygos vein, *i. e.* secondary vein not the persistent postcardinal, that vein is continuous posteriorly with a longitudinal vein which receives lumbar branches and opens indirectly or directly into the post-caval vein. This part of it I regard, for reasons already put forward, as a portion of the persistent postcardinal. Now it is precisely among the Diprotodont Marsupials, whose azygos veins are, as I think, true postcardinals, that we find a very large vein continuing into the abdominal and even pelvic region of the body\*. It seems to me that there is some significance in this fact, and that it tends to support my contention that among adult mammals the azygos veins fall into two categories.

(10) *The Condition of the Azygos and the Classification of Mammals.*

It is clear from the facts here set forth, that the condition of the azygos vein or veins has a distinct relation to the mutual affinities of the several groups of Mammalia, but in quite a general way. Thus the Lemurs agree with the other Primates in having only the single right azygos; and, moreover, it is in these two groups alone that an hemiazygos is at all prevalent on the left side, joining the azygos some way before the latter opens into the right vena cava superior. All the members of the Order Carnivora agree with each other in the same character; the divergences in these three orders or two orders being of the slightest when compared with some other groups. I do not infer from this that there is a special relationship between the Carnivora and the Primates of course. Both groups have, as I think, independently arrived at the same state of affairs as regards the azygos vein. But for each group considered alone the facts at least agree with the general view of their affinities. It is important to note that the Lemurs agree with the Apes, and the Arctoid Carnivora with the Æluroid. No difference in mode of life seems to have affected this deep-seated character. The Otter cannot be distinguished in this particular from the Civet Cat, or the Raccoon from the Suricate.

\* Hochstetter, however, declines to recognise as persistent sections of post-cardinal Robinson's description and figures of a left postcaval extension of azygos (Studies in Anat. Owens Coll. i. 1891, pl. vi. figs. 1, 2, &c.). But it does not follow that this objection would apply to *Macropus*.

Again, the cavicorn Ruminants mostly agree with the Suidæ in the entrance of the left azygos into the heart independently of the remains (if they exist) of the left vena cava anterior. And in this *Moschus* and *Hydropotes* agree with them. This agreement is not without interest, particularly when it is considered that the Cervidæ may differ in the relations of the azygos: in *Cervus sika* the right azygos being the prevalent or only azygos and entering in the usual way the right anterior cava. Most zoologists separate the solid-horned from the hollow-horned Ruminants, though to others the distinction between the two groups of Artiodactyles appears "fanciful." In any case the Perissodactyles have their own plan of azygos structure, which happens to agree with that of some Cervidæ, but distinguishes the Suborder from the Pigs and hollow-horned Ruminants. In connection with the classification of the Ungulates, as supported by the disposition of the azygos veins, the position and number of these veins in *Hyrax* are of particular interest. In this "subungulate," admittedly primitive, and standing nearer to the base of the Ungulate series than any other living form, except the Elephant, there is as it were a hesitation to adopt definitely the form of the azygos veins to be seen in either Artiodactyle or Perissodactyle.

It may also be fairly said that a low position in the series is indicated by the persistence of both azygos veins. These persist in *Echidna*, and are very generally prevalent in the Marsupials, the Rodentia, and, though here our knowledge is more deficient, in the Insectivora. It is the general opinion that of these groups at least three are primitive groups, and many would think the same of the Rodentia. The division of the Marsupials into Diprotodont and Polyprotodont is justified by the condition of the azygos veins; for in the Diprotodont division there is a much greater tendency for the two azygos veins to persist than among the Polyprotodonts. Furthermore, as emphasising the gap that separates the Marsupials from most of the higher mammals, it is noteworthy that in them (*i. e.* the Marsupials) it is the left azygos which is apt to be predominant and not the right vessel. In the Order Rodentia also the conditions of the azygos agree with current views as to their subdivisions. On the whole the Hystricomorphine Rodents are those in which the two azygos veins persist to a greater or less extent. An exception to this statement would appear to be the genus *Dipus*. But it must be remembered that the late Dr. Dobson concluded from certain facts in muscular anatomy that *Dipus* was not remote from the Hystricomorpha\*.

(11) *The Position of the Azygos with reference to the Vertebrae.* †

In dealing with the development of these veins in Mammals, Hochstetter has dwelt upon the fact that the heart moves backwards and with it of course the blood-vessels, including the

\* Journ. Anat. Phys. xvii. 1883, p. 177.

Ductus Cuvieri, attached thereto. The opening of the posterior cardinal veins into the Ductus Cuvieri thus undergoes an alteration of position with reference to the thoracic vertebræ. Thus Hochstetter found that in the embryo of a rabbit fifteen days old "Der Stamm der V. azygos mündet schon in der Höhe des Zweiten Intercostalraumes in die Hohlvene ihre Seite,"\* while in the adult its position is further back. It is interesting to note in relation to such developmental facts the varying position of the entrance of the azygos into the precava in different families and genera of adult Mammals. It would seem plain that if the azygos vein or veins enter the precava further forward in one form than in another, the conditions are in that type more primitive.

On the whole it would appear that as a general rule the point of entrance of the azygos vein is opposite or about opposite to the fifth rib. It is at any rate so in *Macropus*, *Lutra*, *Sciurus*, *Suricata*, *Equus*, *Lemur*, &c. It seems to be the general position among the Carnivora and Primates. I have not met with any instance of a shifting backwards further than this point, more than the very smallest. I have noticed occasionally that the sixth rib instead of the fifth is the first to emit an intercostal to the azygos. This was the case, for example, with a new-born *Ovis tragelaphus*. Now, although Hochstetter and McClure (working it is true with different types) disagree as to how much exactly of the embryonic postcardinals persist in the adult as the azygos vein or veins, there is no doubt that the actual orifice of the azygos into the precava represents the embouchure of the postcardinal into the Ductus Cuvieri. We can, therefore, argue concerning the shifting position of this point. Dr. McClure has himself observed † that the left azygos of *Didelphys* "opens into the left precava about opposite the head of the third rib," while "the right azygos vein, when present in the adult, opens into the precava about opposite the head of the second rib." It cannot be said, however, that this position of the azygos, which is to be regarded as a more primitive position, is in any way characteristic of the Marsupials. It does nevertheless occur in that group, and I have found the same in *Pseudochirus peregrinus*. It is interesting in relation to this matter to find that in the Insectivore *Erinaceus* the Ductus Cuvieri on both sides of the body lies opposite to the interval between the second and third ribs. The Rodents also show to some extent the same anterior position of the point of entrance of the azygos into the precava. Thus in *Hystrix cristata* the first affluent of the right azygos arises between the third and fourth ribs. On the other hand, among the Carnivora and Primates, as already said, this forward position of the entrance of the azygos is never (in my experience) to be met with.

Indeed, the facts stated at length in the preceding pages, which have just been briefly reviewed, point distinctly to the persistence

\* Morph. Jahrb. xx. 1893, p. 573.

† American Journ. Anat. 1903, p. 195.

of a more primitive position of the Ductus Cuvieri in animals which possess as a rule two azygos veins, and are thus also primitive in this peculiarity, and which moreover are usually assigned on these grounds to a low place in the Mamalian series. The whole group of facts fit in with each other in perfect harmony. I believe that these facts are not without importance in considering the Artiodactyle Ungulates, or rather the hollow-horned Ruminants and the Pig tribe, which agree in the characters of the azygos veins.

The right azygos in these animals is always situated far forwards, beginning even (*e. g.* in *Oryx beatrix*) with the second intercostal space, and although the left and prevalent azygos does not occupy what is *ex hypothesi* a primitive position, there are nevertheless true azygos veins present. The anterior section of the azygos, which runs forward of the point of opening into the heart, is perhaps to be regarded as the left precaval otherwise missing. There is thus some agreement with the suggestions already made.

(12) *The Venæ Intercostales Supremæ.*

These veins, so named by Hochstetter, and often termed inferior intercostals, are superficial veins made up of one or more of the intercostals anterior to those which unite to form the azygos vein or veins. They are the superficial superior intercostal veins of McClure\*. As will be gathered from the foregoing pages, these veins are not invariably present as trunks opening into the vena cava superior; nor indeed are they invariably present at all. I presume that in these cases, where no such veins are apparent, the circulation is effected by the deep series of intercostal veins lately figured† with great elaboration in the *Opposum* by Dr. McClure in the paper already referred to. The details of the occurrence of these veins in various genera of mammals have been already dealt with in the foregoing pages. From these it will appear that the veins in question are by no means of universal occurrence, and that when they do occur they are not always connected with the precaval vein or veins. In man, for instance, these veins are described as entering the left and right venæ anonymæ respectively. This appears to hold good for the Primates generally.

But I do not profess in the present communication to have dealt at any length with the Primates. Among the Carnivora these veins are evidently not common, and when they do occur sometimes join the precava and sometimes the vena or venæ anonymæ. In the Marsupials also the venæ intercostales supremæ are not universal, but when they are met with they seem as a rule to join the precaval or precavals. These veins are much more general among the Hystriciform Rodents, where indeed, so far as my observations go, they are practically universal and join the precaval. As a rule, too, in this group the veins are paired and

\* Amer. Journ. Anat. vol. ii. 1903, p. 371.

† *Loc. cit.* fig. p. 380.

each precaval has its own separately debouching intercostals. That this is not at all due to the prevalence among these Rodents of two precavals is shown by the same constancy of the *venæ intercostales supremæ* among the Artiodactyle Ungulates. The exceptions that I have met with to the rule that these veins are present on both sides and open into the single precaval are but few in number. Concerning other groups the facts at my disposal are so few that I hesitate to attempt any remarks of a general character.

### (13) *Conclusions.*

Although the facts detailed in the preceding pages, as well as those made known by the records of others, might be largely added to, enough appears to me to be known to permit of a few general observations upon the azygos vein in the Mammalia.

(1) With the exception of the Cetacea the azygos is always a well-developed vessel of fair size among the Mammalia, and generally to be found fully developed upon one side of the body only, and this the right. Its functions appear never to be taken up by the *vena cava inferior*, so that it is never rudimentary.

(2) There is only a right azygos with no traces of a left—except rarely as a hemiazygos not reaching the *vena cava anterior*—in Carnivora, Lemurs, American Edentates, and Primates.

(3) The existence of two azygos veins characterises several Marsupials, Rodents, Insectivora, and most Artiodactyles. In the two first-named groups the existence of the two veins is associated with the presence of two superior *venæ cavæ*. It is not, however, every Rodent with two superior *cavæ* which has also two *venæ azygos*. But, as it appears, no Rodent with one superior *cava* only has more than one *vena azygos*. The Artiodactyles are exceptional in that, while possessing only a single anterior *vena cava*, there are two azygos veins. But the left azygos generally opens into the right auricle with or close to the *vena cava posterior*. Rarely there is also a connection with the single *vena cava anterior*. Where two azygos veins are present it is unusual for them to be equally developed. Either the right or the left is well developed and the other smaller or much reduced.

(4) The existence of a left azygos only characterises a few forms belonging to the groups Marsupials, Rodents, and Artiodactyles. This condition of the azygos is not, like the two which have been dealt with, characteristic of any large group.

(5) It is to be remarked that, on the whole, the possession of two azygos veins is associated with a low position.

(6) With certain exceptions (e. g. *Æpyprymnus rufescens*) the azygos vein is fairly constant in its characteristics for a given species. This is sometimes very markedly the case.

(7) As will be gathered from the details given, the azygos is of some use in the classification of Mammals. Thus *Hyrae* shows its Ungulate affinities, and several genera of Hystriiform Rodents agree together in the character of the azygos veins, &c.

(8) As a general rule the entrance of the azygos vein or veins into the precava or precavals is more anterior in position in Mammals, occupying a lower position in the series than in more specialised types, *i. e.* opposite to second rib instead of fifth or sixth. This corresponds with ontogenetic shifting back of heart and blood-vessels.

(9) The conditions observable in the newly-born young of *Myopotamus coypu* seem to show that the postcardinals may persist as such at least up to the time of birth, and in some adult Rodents one is also persistent.

(10) The same species shows that the azygos of the adult is independent - except for a very short tract at its opening into the precava - of the postcardinal of its side, thus confirming the embryological results of others who have affirmed that only the very commencement of the azygos is traceable to the persistent postcardinal of its side.

(11) It is probable that the veins called "azygos" in adult Mammals are not in every case strictly homologous veins. Where there is but one azygos present (*e. g.* Carnivora) it is probable that that vein is the true azygos, except in the abdominal region where it is formed by the persistent postcardinal. In cases where there are two azygos veins both may be (? certain Marsupials) persistent postcardinals, or one of the two may be a remnant of the postcardinal, the other being a true azygos.

(12) These and some other facts and conclusions lead to the inference that the true azygos vein of Mammals (*i. e.* that formed by an outgrowth of the postcardinal) is a structure which has been developed in the Eutheria.

## 5. Ideas on the Origin of Flight.

By Dr. Baron FRANCIS NOPCSA.

[Received February 8, 1907.]

(Text-figures 74-82.)

Although much has been written on the origin of flight, yet till now no really satisfactory explanation for this kind of locomotion has been found. This is, so far as I can understand, mainly due to the fact that it has on *à priori* grounds been supposed that all the principal groups of flying vertebrates—namely, Pterosaurs, Bats, and Birds—originated in a similar manner, without fully appreciating the fundamental fact *that, from the mechanical standpoint, patagium and feather are two perfectly different organs.*

A patagium is a soft flexible membrane and in consequence requires, to be effective, numerous firm radial supports originating from the body that has to be carried, whereas for a series of semirigid but elastic quills one line of attachment is sufficient.

In consequence of this difference, a patagium-flyer must always

adapt fore and hind limbs and tail to the support of the patagium, whereas in a generalised feathered animal only the feather-supporting elements need become affected by violent specialisation. The development of the posterior limb in such an animal is but little, if at all, affected by the development of flight (foot in Eagle, Parrot, Woodpecker, Nightingale, Goose, Stork, Ostrich, &c.).

As to flight itself we have to distinguish, as partially already pointed out by Dollo, three distinct stages of evolution: first parachute or *passive flight*, then flight by flapping the wings or *flight by force*, and lastly soaring or *flight by skill*.

As Langley and Lucas pointed out in their highly interesting papers, the soaring birds lack carrying power (in accordance with which fact the crista sterni is often comparatively feebly developed), while flight by flapping of the wings, as shown by the generally soaring Eagle when carrying prey, enables the animal to support a good deal of weight.

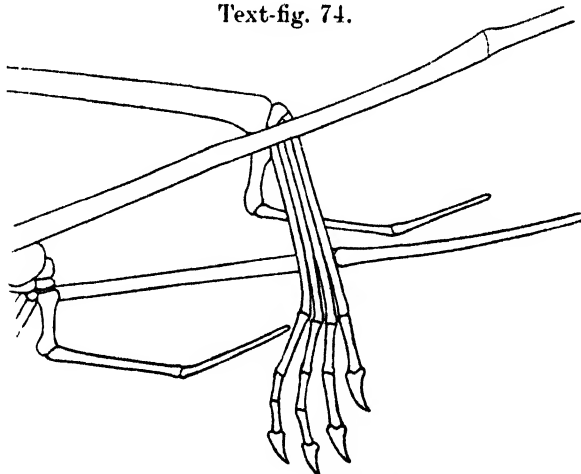
That soaring birds show a sharply pointed wing, while birds that fly mainly by flapping display a wing with a more or less rounded outline, is well known.

After these preliminary, but I think essential, observations, I shall now point out some characters of Pterosaurs, flying Mammals, Dinosaurs, and Birds that have not yet been brought together.

#### PTEROSAURS.

The *Dimorphodon*, till now the earliest-described long-tailed

Text-fig. 74.



Hind limb of *Dimorphodon*

Pterosaur, shows in its hind limb no sign whatever of cursorial locomotion (text-fig. 74). The metatarsals 1-4 are equally developed,

but the 5th is somewhat thicker and also much shorter. The elongate phalanges of the 5th toe further prove clearly that no *cursorial* adaptation modified the form of these bones. Very much the same type of foot is visible in the equally long-tailed *Campylognathus*; and when we turn to the *Rhamphorhynchus* of the Solenhofen Slate (text-fig. 75), we find not only no cursorial modification of the four-toed slender foot but quite decided degeneration. However, according to Zittel, the number of phalanges in the 5th toe is perhaps somewhat greater than in the drawings given for *Dimorphodon* or *Campylognathus*. Since the spur-like clawless 5th digit of the foot is very strongly developed in *Dimorphodon*, there is, as Owen observed, good reason to believe that a

Text-fig. 75.



Hind limbs of *Rhamphorhynchus*.

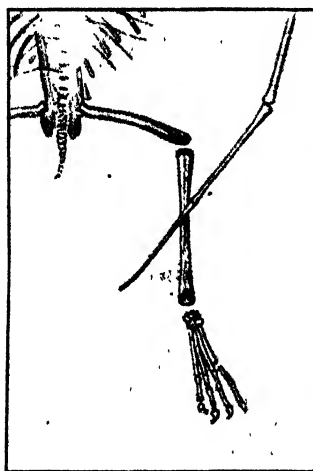
uropatagium was not only present but even very well developed; whereas we know that in *Rhamphorhynchus*, in accordance with the less developed 5th toe, no uropatagium extended to this part of the body. The resemblance of the *Rhamphorhynchus* sternum to that of the Bat (*Taphozous*) likewise has to be noticed.

That in the Liassic *Dimorphodon* the wing-finger is relatively shorter than in the Tithonian *Rhamphorhynchus* is a fact so obvious as scarcely to demand attention. The short-tailed Pterosauria of the genus *Pterodactylus*, with comparatively short wing-bones, resemble *Campylognathus* in having four feeble and



equally strong metatarsals which all approximately attain the same length, while, in harmony with the lack of a tail, of the 5th toe only a rudiment (text-fig. 76) now remains. Among Chiroptera we find that in the tailless forms, notably *Pteropus*, quite similarly the os calcar of the hind leg is less developed than in the long-tailed species.

Text-fig. 76.



Hind limb of *Pterodactylus*.

(The rudiment of the 5th toe is unfortunately not shown in this drawing.)

On account of the anterior prolongation of the ilium in Pterosaurs, and on account of the great number of vertebræ united in the sacrum, it has been frequently assumed that the Pterosaurs enjoyed a bipedal locomotion. Both these arguments, however, fail to convince me, and this principally on account of *Nyctosaurus*, which, although certainly not a bipedal genus, has a still greater number of sacral vertebræ, and because in *Pteropus* there is likewise a pseudosacrum present. Another argument that can be brought forward as annulling the hypothesis just mentioned consists in the fact that the Pterosaur pelvis, though showing considerable length, has an ilium of an exceedingly low and narrow *Bat-like* outline.

A Pterosaur of whose crawling habits we can be quite sure is, as just mentioned, the Upper Cretaceous *Nyctodactylus*, for, as Williston pointed out, the acetabulum is placed far back, nearly over the edge of the sacrum, so that it was impossible for the knees in this animal to meet in the middle, and at times the knees may even have been turned more or less backward. When the femora were rotated outward and abducted, the tibiæ might have been brought parallel with each other. Exactly similar conditions are

to be met with among Bats, whose crawling locomotion is familiar to every student.

The elongation and attenuation of the hind feet in *Nyctodactylus* (text-fig. 77) are also characters that demand mention, and a similar elongation is again to be met with in the tailless Vampires.

An interesting feature is the co-ossification of numerous dorsals in *Nyctodactylus* and the nearly allied European genus *Ornithocheirus*.

Text-fig. 77.



Hind limb of *Nyctodactylus*.

(Photograph of specimen in the British Museum.)

A Triassic long-tailed Pterosaurian, *Tribesodon* (the detailed description of which I intend publishing on some other occasion), shows much the same proportion between total length of hind and fore limbs as does *Galeopithecus*; and, although *Galeopithecus* proves to be in no way related to Chiroptera, still we must suppose that the whole order Chiroptera, considering the patagium, passed through a *Pteromys*- and a *Galeopithecus*-like stage in the course of its evolution.

Since, as already pointed out, a patagium requires many spear-like supports, and since in arboreal animals fore and hind limbs are to the same extent used for running and leaping, it is evident that primarily fore and hind limbs must have become to the same extent used for the support of the patagium, which necessarily had to take origin at the centre of gravity between humerus and femur.

As soon as such a potentially flying animal became actively

volant, and began to fly by force—that is, move its patagium,—the sternum must evidently have developed a sternal crest, the patagium must have continued to increase its surface, and this then would not only produce stretching of the limbs but also development of secondary supports of the patagium.

Such secondary supports are, as we shall see, developed at different times and in different ways, being produced by special development of the olecranon, the carpal bones, and ossified tendons. In the long-tailed Pterosaurs such supports are absent in the fore limb; in the short-tailed Pterosaurs, however, they are well developed and are represented by a modified carpal which, according to Williston, shows (*Pterodactylus*—*Nyctodactylus*) progressive evolution. Another modification that each patagium produces in the animal's body is to bring all the radial supports to the same level, and this, making the acetabulum and knee rotate outward and backward, produces subsequently crawling locomotion.

When the last stage of development is attained and aerial locomotion accomplished by skill and not by force (*Nyctodactylus*, *Rhamphorhynchus*), the patagium obviously not only would assume a pointed outline and become reduced to a smaller surface, but in some cases also the tail would change to a rudder-like organ (*Rhamphorhynchus*) or become entirely lost, while the attenuated feet would in this case assume the function of steering (*Nyctosaurus*). It is of no small importance that of the two highly specialised groups of Pterosaurians (*Rhamphorhynchidae* and *Nyctosauridae*) the tailless ones should have survived the longer.

#### MAMMALS.

Very much the same changes as are to be found between *Tribelesodon*, *Dimorphodon*, and *Rhamphorhynchus* on the one hand, and *Pterodactylus* and *Nyctodactylus* on the other, are also to be observed when we come to consider the patagium-flying Mammals. A set of good diagrams of flying mammals has recently been published by R. S. Lull. *Petaurus* and all other animals with a small patagium represent the stage where, as in all arboreal animals, a very long tail is present.

Only a plagiopatagium is present in *Petaurus*, a propatagium is added in *Pteromys*, whilst in *Anomalurus* even a uropatagium is present. As in Pterosaurs, supplementary patagial supports are frequently developed. In *Anomalurus* and *Vespertilio* such a support arises from the olecranon, in *Pteromys* it is partially attached to the pisiforme and partially, though to a less extent, to the 5th metacarpal; and in embryos of Chiroptera quite a similar structure is met with: a modification recalling the backwardly directed toe of the hind leg in *Dimorphodon* is produced by the development of the calcaneum's calcar projection. As in Pterosaurs, so also in flying Mammals a very low ilium is present, and this not only in Chiroptera but also in *Galeopithecus*, where,

even during ontogenetical evolution, a backward rotation of the ischium, and in consequence a flattening of the pelvic girdle, is to be met with. *Pteromys* and *Anomalurus*, according to Dollo, have to be termed passive flyers: the first partially active flyer seems to be *Galeopithecus*, for, according to Wallace, this animal is not only capable of sailing downward, but at the end of its downward oblique glide to rise a little upward.

*Galeopithecus*, however, is a long-tailed, comparatively short-armed patagial animal, in which nevertheless the patagium extends even to the tips of the digits and to the end of the tail; while when we turn from this to the specialised actively flying Chiroptera, we are impressed firstly by the elongation of the wing, and secondly by the frequent partial or total loss of the tail.

Both in Pterosaurs and Bats the main movement during flight seems to have been, and still is, dependent on the humeral articulation. The similarity of the patagial structure in *Rhamphorhynchus* and Bats, as remarked by Zittel, is also to be noted. The hairless condition of the patagium in Chiroptera compared with *Galeopithecus* is likewise a more specialised feature; while *Pteropus vulgaris* (more specialised than any Bat in regard to the caudal region, "chevauchement de spécialisation") shows, by possessing some hair on the interior surface of the patagial membrane, an intermediate stage.

In Pterosaurs, as also in *Pteropus*, the number of sacra is augmented, and in the latter they even form, by co-ossifying with the ischium, a pseudosacrum.

The more or less perfect reduction of tibia and ulna is another character that is noteworthy in all patagium-bearing Mammals.

In an analogous manner to the Cretaceous *Ornithocheirus*, also in some Bats a rigid thorax is attained, though in this case the ribs and not the vertebrae co-ossify.

Since we may safely assume that Bats descended from Mammals which possessed a well-developed neural spine, the reduction of this process, noticeable also in the Flying Lizard (*Draco volans*), has also to be considered as a sign of specialisation.

The thin and dense skull-bones also unite in specialised Bats, very much as in Birds and Pterosaurs; and as to the brain, there exists a great amount of resemblance between the cast of the brain-cavity in some Eocene Bats, in *Hesperornis*, and in *Scaphognathus*.

Only in one point is there a pronounced difference between the Pterosaurs and the Bats, and this is in the transformation of the phalanges of the pes and manus. While in the Pterosaurs a reduction of the claws takes place in the pes, and they remain present in the manus, in Chiroptera exactly the opposite happens; but this divergence is easily understood when we consider that the Chiroptera had, in consequence of adapting four fingers to flight, only their hind feet at their disposition, for resting and suspending on branches, while the Pterosaurs, which developed only one

wing-finger, could always suspend themselves by the remaining free digits. This is, perhaps, also the reason why, in both groups, ulna and radius, tibia and fibula have been reduced in a different manner. In Birds the same problem has been solved in quite another manner (musculus ambiens and peculiarities in the structure of the tendon-sheath of musc. flexor. digit. in the phalanges). Text-fig. 78 shows the hind limb of a Bat identified by Dr. K. Andersen as *Hipposiderus gigas*.

Text-fig. 78.



Hind limb of *Hipposiderus*.

Since all flying animals must needs have developed from agile quick-moving animals, since all living patagium-flying animals (such as *Draco volans*, and the other living animals mentioned in this paper) are arboreal, leaping, quadrupedal creatures, and since, further, a bipedal cursorial animal, on account of mechanical impossibilities, can never develop a patagium—for such an organ would in bipedal (*i. e.*, erect) locomotion only catch the air and so prevent running without raising the body,—and since the union of fore and hind limbs is directly opposed to bipedal cursorial locomotion, we can safely state that all patagium-flying animals originated from quadrupedal, leaping, arboreal forms.

Bats and Pterosaurs, though they support the wing in different ways, still show an analogous direction of evolution—as shown by the development of a patagium with all that this implies; thus we may safely state that *Bats and Pterosaurs have arisen in similar manner from quadrupedal arboreal forms.*

## DINOSAURS.

In consequence of the quite extraordinary tendency of Dinosaurs to specialise every now and then along Avian lines, and in consequence of the fact that the most primitive Dinosaurs are bipedal in their habits, it is not only probable that all Dinosaurs originated from bipedal forms (I only need to quote the numerous bipedal tracks in the Red Triassic Sandstone in Connecticut), but that they also are very nearly related to the primitive Birds.

Since Dr. Holland thinks that the Dinosaur likeness to Birds is sometimes greatly exaggerated, I would like to mention some of the most characteristic primitive and adaptive Avian features of Dinosaurian reptiles: basis cranii (*Hypsilophodon*, *Compsognathus*), development of beak (Orthopoda, beak perhaps developed independently in different suborders, caused by latent homoplasy), lack of neural spines in cervical vertebræ (Sauropoda), dorsal neural spines bifid (*Diplodocus*), saddle-shaped articulating surface of sacrals (*Streptospondylus*), synsacrum (Orthopoda), *Apyornis*-like caudals (*Diplodocus*), Avian scapula (Orthopoda, Theropoda), co-ossification with the coracoid (all Dinosaurs), manus (*Ornitholestes*), ilium covering last ribs (Sauropoda), ilium touching neural spines (*Stegosauridæ*), ilium showing antitrochanteric ridge and dorsal plane (Theropoda); backward rotation of pubis and subsequent development of processus pseudopectinealis (Orthopoda), femur shorter than tibia (many Dinosaurs); reduction of fourth trochanter (all Dinosaurs), distal end of femur (*Streptospondylus*, &c.), development of processus ascendens astragali (Theropoda), fusion of calcaneum and astragalus with tibia (*Compsognathus*); position of hallux (Theropoda); pneumaticity or light structure of the whole skeleton (many Dinosaurs).

In a paper on the evolution of Dinosaurs, I pointed out that the Theropoda specialise by developing an interpubic ossification, by augmenting the number of their sacrals, by changing the character of their vertebræ from biconcave to opisthocelous, by lengthening their neural spines in the dorsal region, and by developing a proc. asc. astrag. and reducing the number of their toes. In more specialised Theropoda the metatarsals become always more closely applied, and, lastly, these animals specialise by losing the fourth trochanter. Most of these changes are also notable among the bipedal Orthopoda, and since this development is independent of that in the Theropoda, we must consider them as homodynamic changes; besides this, in Orthopoda we can trace a thickening of the bony matter and the development of a processus pseudopectinealis. A functionally analogous osseous process is developed in most running birds after the co-ossification of the pelvic elements.

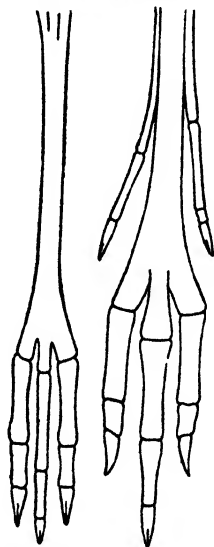
Since we can be sure that in Dinosaurs all the changes mentioned are not due to the giving up of volant habits, but are merely signs of cursorial adaptation, we have a clue to understand some of the changes that occur among the Palæognathous Birds. Besides this we can fix the fact that the Dinosaurs, like

many cursorial Mammals, were not only set the problem of developing a flexible dorsal vertebral column, which was attained by development of convexo-concave intervertebral articulation, but that to this, in consequence of the position of their head, they had to add strength in the vertical direction, which could only be attained by developing the attachment surfaces for the *musculus longissimus dorsi* on the neural spines and the producing of hypapophysis-like knobs on the cervicals. This, moreover, is the first consideration adduced since 1887 that shows us that the vertebral column of *Iguanodon*, though provided with ossified tendons, cannot have been altogether rigid. Text-fig. 79 is intended to show the highly modified foot of the Cretaceous Dinosaur *Ornithomimus*, and can be compared with the feet of *Dipus* and *Aluctaga* (text-fig. 80).

Text-fig. 79.



Text-fig. 80.

Text-fig. 79.—Hind limb of *Ornithomimus*.80.—Hind limbs of *Dipus* (left) and *Aluctaga* (right)

#### BIRDS.

Leaving Dinosaurs and turning to Birds, we observe the following salient points:—

The first and most primitive Bird we know, *Archæopteryx* (text-fig. 81), shows not only a perfectly bird-like femur and tibia, but also tridactylism, and this is, as demonstrated by Dinosaurs and the *Dipus*-like rodents, a prominent feature of bipedal cursorial or saltatorial specialisation, while it never occurs among arboreal forms.

The pelvis of *Archæopteryx*, moreover, is essentially that of a Bird,

and as a sign of cursorial locomotion there is even an indication of a *processus pectinealis*. The vertebrae are free, and neural spines are present.

Besides this, *Archæopteryx* differs from all Birds by having a long laterally feathered tail, that to a certain degree reminds us of the peculiarly covered and flat-looking tails in the mammals *Acrobates* and *Ptilocercus lowi*.

Text-fig. 81.



Hind limb of *Archæopteryx*.

(Photograph of the British Museum type specimen.)

The ossified tendons which occur in the tail of *Archæopteryx* show further that strength of this organ was required just as much as in the tail of *Dimorphodon* or *Rhamphorhynchus*. A long tail, sometimes even with ossified tendons, is quite a marked feature of the Dinosaurian bipedal reptiles, and its loss, as shown in Pterosaurs, is generally in harmony with the better adaptation to flying locomotion.

The rounded contour of the *Archæopteryx*-wing, together with the feebly developed sternum, show us that *Archæopteryx*, though perhaps not an altogether badly flying creature, can on no account have been a soaring bird, but a bird that was yet in the first stage of active flight.

That the soaring Frigate-Birds and Albatrosses have a comparatively weaker sternum than the Gallinaceous Birds has already been mentioned; and I therefore need only point to the formation of a rigid thorax in flying birds as analogous to the condition in Pterosaurians and Bats and in opposition to the Ratites, and to the fact that the cursorial Palaeognathæ, contrary to the flying



Tinamous, possessed not only free vertebræ, but even elongate, Dinosaurian-like neural spines in the dorsal region, and this because also in this case, for running, strength had to be united with mobility in the dorsal region, whereas for flight, as already mentioned, strength and rigidity seem to be the qualities required, so that the neural spines become to a certain extent useless. It is especially to the curious dorsal and caudal vertebræ of *Epyornis* that I should like to draw attention. Probably mobility is one of the reasons why in the flightless *Hesperornis* saddle-shaped vertebræ were developed at a period when *Ichthyornis* still showed biconcave articulation, although I am quite aware that perhaps other explanations will have to be sought for, since also in other ways *Hesperornis* indicates a more specialised form, and this not only by its wing-bones being already reduced, but by exhibiting a certain tendency to lose its teeth, since these are no longer placed in distinct sockets as in *Archæopteryx* and *Ichthyornis*, but in a furrow.

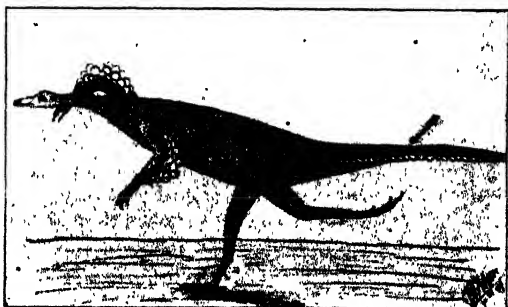
If we, after these preliminaries, now suppose that Birds, before attaining the *Archæopteryx*-state, originated from quadrupedal arboreal animals and only after having learnt to fly became bipedal, it is difficult to understand why they in general show Dinosaurian affinities, why they did not use both hind and fore limbs to the same extent for flight as they would have done for arboreal locomotion, why the bones of the pectoral region and of the wings show more primitive traces than the hind parts of the body, and why they did not, like all other quadrupedal flying animals, develop a patagium; whereas, if we consider that in *Archæopteryx* the anterior extremities, though bearing the most important ectodermal pinions, are less modified than the posterior extremities, which are already perfectly bird-like, and if we then suppose that Birds originated from bipedal Dinosaur-like Reptiles, it is easy to understand what induced the Birds to attain an *Archæopteryx*-like stage of evolution, for at first a certain amount of bipedal, and only afterwards a volant, modification would be required.

While we can safely state that a bipedal animal never could or did develop a patagium without giving up bipedalism, this cannot be said of feather-bearing forms, for we may quite well suppose that birds originated from bipedal long-tailed cursorial reptiles which during running oared along in the air by flapping their free anterior extremities. If Dinosaurs had bird-like pulmonary appendages, as indicated by the pneumaticity of the skeleton, such movement would only have been of advantage for the respiratory organs (the pneumatic foramen occurring sometimes in Moa-bones would therefore be an atavistic feature, and the loss of pneumaticity would be a parallel to the same change in the Dinosaurian subclass). At this point the pulmonary appendages of Chameleons have also to be taken into consideration. A double running and flapping action would—somewhat in accordance with Pycraft's views on this subject—subsequently easily lead to an enlargement of the posterior marginal scales of the antibrachium, and at the same time produce a certain amount of bipedal specialisation.

By gradually increasing in size, the enlarged but perhaps still horny hypothetical scales of the antibrachial margin would

in time enable the yet carnivorous and cursorial ancestor of Birds to take long strides or leaps, much in the manner of a domesticated Goose or of a Stork when starting, and ultimately develop to actual feathers; this epidermic cover would also raise the temperature of the body, and thus help to increase the mental and bodily activity of these rapacious forms. The possibility of such a development of flight is clearly shown by the somewhat analogous, but still more marvellous and nearly paradoxical, yet not unfrequent, development of Flying-Fishes. The marginal scales being originally the principal wing-element in such a hypothetical form, these parts could attain quite a considerable size without essentially altering the underlying bones of the arm, a fusion of the carpal phalanges being only then necessary, when in flight rigidity of this region became requisite. Besides this, the continued use of the anterior flapping limbs as

Text-fig. 82.



Hypothetical reconstruction of a running "Pro-Avis."

grasping-organs would also account for the feeble specialisation of the digits in the *Ornitholestes*-like manus of *Archæopteryx*, and for the preservation of the claws in the Ostrich and *Opisthocomus*, where, according to Pycraft, the temporary delay in the growth of the distal pinions has been developed simply not to prevent the claws from performing their still not unimportant function. An effort to condense these hypothetical changes into a drawing is given in text-fig. 82, which might in consequent allusion to Pycraft's analogous reconstruction be called a "Pro-Avis."

The facts that even from the Eocene formation in most parts of the world numerous big Ratites are known, which can only have originated from badly-flying ground-birds, whereas in more modern times the Ratites are apparently vanishing from the earth's surface, likewise find quite an easy explanation in the hypothesis that in the Mesozoic times badly-flying ground-birds, and *not* tree-birds, were the prevailing forms. The individual or ontogenetical development of every cursorial Carinate (for example, every gallinaceous bird) would thus show us the exact manner in which flight has been acquired. The true phylogenetic value of the surviving "Palæognathæ," with their body-temperature

decidedly lower than in other birds on the one hand (Sutherland), and their reduced brachio-sternal muscles on the other (Fürbringer), can likewise be appreciated only if we consider them as forms that specialised at a very early stage of Avian evolution.

It is to be remarked that among the terrestrial birds which according to this hypothesis would seem to have preserved their original mode of living and manner of breeding, the nest-building faculty is less developed than in those birds which, to avoid the dangers of ground-life, migrated up into the trees and had then to shelter their eggs and young ones from the new chance of falling to the ground. That ground-life involves for a bird more dangers than life on a tree, I think, is shown by the fact that the true ground-birds usually are protectively coloured, while in the latter, even among Gallinaceous Birds, bright—one might nearly say artistic—sexual characters are frequently developed.

The supposition, that Birds once possessed a patagium and only afterwards developed feathers, I consider as devoid of foundation, for apart from the impossibility of a marginal feather being effective, when only attached to a flexible membrane, it is loss and not development of hair and scales (= epidermal coverings) that takes place in the Chiropterygian and Pterosaurian patagium. Besides, I do not see any reason why a useful patagium, once developed, should suddenly have stopped growing.

The long tail in *Archæopteryx* can in no way be invoked in favour of a primitive arboreal stage of Birds, for a long tail not only characterises arboreal but also bipedal cursorial and saltatorial forms. Thus we cannot find a single character in *Archæopteryx* that would absolutely prove arboreal specialisation, while the development of the cannon-bone alone is sufficient to show with certainty that some of the direct ancestors of *Archæopteryx* had cursorial habits.

#### CONCLUSION.

From a consideration of the whole of the above remarks, we can, I believe, formulate the following statement:—

*While Pterosaurs and Bats originated independently from quadrupedal arboreal forms in which both anterior and posterior extremities, in consequence of the development of a patagium, became primarily equally used for flight and in consequence equally unfit for locomotion on the ground, Birds originated from bipedal Dinosaur-like running forms in which the anterior extremities, on account of flapping movements, gradually turned to wings without thereby affecting terrestrial locomotion. This is also the reason why Birds became dominant over all the rest of their aerial rivals.*

In conclusion, I take pleasure in thanking once more all the gentlemen that helped me to compile this paper, notably Dr. K. Andersen, Mr. G. A. Boulenger, Dr. Forsyth Major, Mr. W. P. Pycraft, and Dr. A. S. Woodward, at the British Museum of Natural History.

March 5, 1907.

FREDERICK GILLET, Esq., Vice-President, in the Chair

The Hon. Walter Rothschild, M.P., F.Z.S., exhibited a mounted specimen of a Gorilla, *Gorilla gorilla diehli*.

The following papers were read :—

1. Descriptions of a new Species and two new Subspecies of Antelopes and a new Sheep. By the Hon. WALTER ROTHSCHILD, M.P., Ph.D., F.Z.S.

[Received March 3, 1907.]

*RIAPHICEROS HORSTOCKI NATALENSIS*, subsp. n.

Differs from *R. horstocki* in its much darker colour. The white patches on the throat and round the eyes much smaller and the white on the belly less extended. The whole of the rest of body, head, and limbs dark vinaceous rufous instead of orange-rufous.

*Hab.* Neighbourhood of Drukensberg, Natal.

*CERVICAPRA ARUNDINEUM OCCIDENTALIS*, subsp. n.

Differs from *C. arundineum* in the paler, more greyish rufous of head and neck and the pale rusty-grey of limbs, tail, and body. The horns also seem straighter and thicker as a rule.

*Hab.* Neighbourhood of Fort Jameson, Northern Rhodesia, and Bangweolo Flats.

*COBUS ROBERTSI*, sp. n.

I am treating this as a species because it occurs in the same territory as true *C. lechwe* and *C. smithemanni*, otherwise it has many characters intermediate between these two species. Nor do I consider it likely that it is a hybrid, for it has been shot by several sportsmen, and not always in the same localities.

Horns stouter and the rings broader and closer together than in *C. lechwe*, smooth tip shorter. Head, hind-neck, body, and upper part of fore-neck bright orange-rufous, back and flanks darker and redder than in *C. lechwe*. Cheeks, throat, and sides of neck have the rufous strongly mixed with black hairs, thus somewhat approaching *C. smithemanni*. Lower fore-neck whitish, with two large black patches on each side, which join similar patches on the front of the shoulders. Outside of ears rufous buff, inner side white.

*Hab.* Northern Rhodesia. (Type, collected by Mr. Roberts.)

*Ovis cowani*, sp. n.

This Sheep is nearest to *O. stonoi*, but differs in being entirely deep black, with the exception of a white rump-patch and a grey face. The rump-patch is considerably smaller than in *O. stonoi*. The three-year old ram of *O. stonoi* is occasionally much darker than a specimen of that species in my possession, but is always of a rusty or brownish black, and has the very large white rump-patch.

The type specimen of *O. cowani* was entire, but the skin had only been dried and not dressed, and when relaxed the whole of the hair came off, and only the head and neck could be saved.

The type, shot by an Indian out of a large flock, was sent me by Mr. C. G. Cowan, of Kamloops, and was obtained in the mountain-chain near Mount Logan in British Columbia.

Types of all these four species and subspecies are in the Tring Museum.

## 2. On Elephant Remains from Crete, with Description of *Elephas creticus*, sp. n. By DOROTHEA M. A. BATE.\*

[Received February 1, 1907.]

(Plates XII. & XIII.†, and Text-figure 83.)

### Introduction.

Perhaps the most important and interesting of the results of the author's visit to Crete in 1904 was the discovery, in two hitherto unexplored cave-deposits, of the remains of Elephants of different sizes, more particularly as the occurrence of one of these, of pigmy proportions, appears not to have been previously known.

Although prior to 1904 no large quantity of specimens seems to have been obtained, yet the existence of ossiferous deposits in this island has been known for a considerable time, as the following records testify. The earliest would seem to be that of Pococke, who described a bone-cave in the Khania Akrotiri in a volume published in the middle of the eighteenth century‡. Nearly a hundred years after this, a reference occurs relating to fossilised human remains found, together with marine forms, near Khania by Fabrequette§, who was at one time Consul at Malta. Later, remains of a Hippopotamus, which probably came from the upland basin of Lassethi, were obtained by more than one traveller||, and have since been referred to by a number of writers. Two ossiferous caves were discovered in the west of the island by

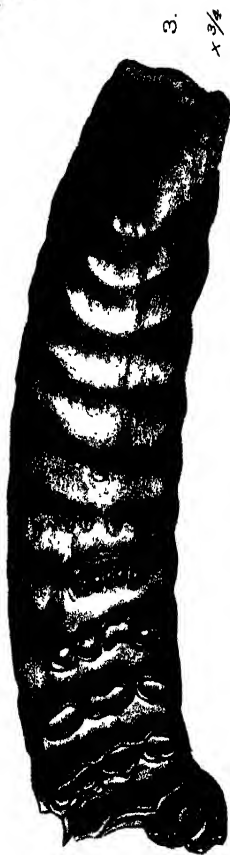
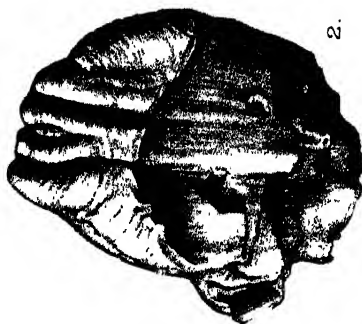
\* Communicated by HENRY WOODWARD, LL.D., F.R.S., V.P.Z.S., F.G.S.

† For explanation of the Plates, see p. 250.

‡ Richard Pococke, 'A Description of the East' (London, 1745), vol. ii. p. 264.

§ C. R. Acad. Sci. (Paris), iv. 1837, p. 182; also *ibid.*, viii. 1839, p. 178.

|| See Admiral Spratt, 'Travels and Researches in Crete' (London, 1865), vol. ii. pp. 386-7; also Raulin, 'Description Physique de l'île de Crète' (Paris, 1869), vol. i. p. 156, and vol. ii. p. 615.



G.M. Woodward del. et lith.

ELEPHANT REMAINS FROM CRETE.

West, Newman imp.





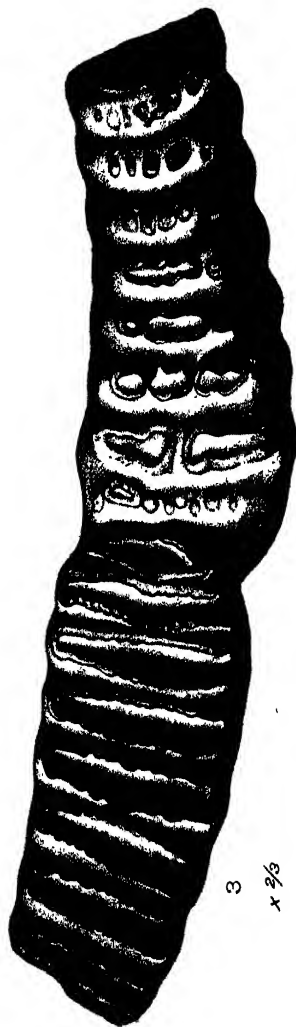
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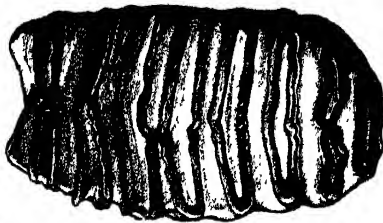
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G. M. Woodward del. et lith

ELEPHANT REMAINS FROM CRETE.

West, Newman imp.





Admiral Spratt\*, both of which have since been visited by the present writer†.

Signor Simonelli, whose geological researches in Crete were carried on in 1893, was seemingly the first to obtain Elephant remains, which he procured from caves near Retymno, which is situated on the north coast and lies between Khania and Candia. In a paper published in 1894‡ he identifies the specimens, which included a perfect mandibular ramus, as those of *Elephas priscus* (= *E. antiquus* §), though no detailed descriptions or figures are given, and I have been able to find no other published reference to them.

Unfortunately the collection of teeth and limb-bones which forms the subject of the present paper consists of a small amount of material only, many of the specimens being but imperfectly preserved. Notwithstanding this they fall naturally into two groups representing animals of different sizes, the smaller of which agrees in this respect with *E. melitensis*, whilst a number of limb-bones indicate an Elephant superior in dimensions to the average Indian species (*E. maximus*) of the present day, but not equalling the gigantic proportions at times attained by *E. meridionalis* and *E. antiquus*, though, as will be shown later, it is to this last that they must evidently be referred. Thus at first sight it seemed probable that the collection included remains of both a dwarfed race and the parent form from which it had sprung. However, before remarking on the relationships suggested by a study of the specimens obtained, it will perhaps be more convenient first to briefly describe them, commencing with those by which the pigmy form is represented.

#### I. *Elephas creticus*, sp. n.

The remains of the smallest of the Cretan Elephants were all obtained from a much damaged and weathered cave-deposit in the limestone cliffs near Cape Maleka in the west of the island, which has already been described<sup>1</sup>, and where only some teeth and limb-bones of small rodents were found besides those under discussion. These latter include nine imperfect molars and a few fragments, among which are a portion of an incisor and the dorsal half of a vertebra. As this small race differs from those of other Mediterranean islands, and its minute proportions being seemingly the result of specialisation due to isolation in Crete, it is suggested that it may be known by the above specific name denoting its island habitat.

*Incisors*.—Of the milk-incisors no specimen was procured, while, as already remarked, only a fragment of the proximal end of a permanent tusk (M. 9375) was obtained. From the limited

\* *Op. cit.* vol. ii. pp. 194-5.

† *Geol. Mag.* n. s. dec. v. vol. ii. (1905) pp. 194-6.

‡ *Atti R. Accad. Lincei*, 5<sup>a</sup> ser. Rendiconti, vol. iii. 1894 Sem. 2, pp. 265, 268; also 'Candia' (Parma, 1897), pp. 171-2.

§ *Cat. Foss. Mamm. Brit. Mus.* part iv. (London, 1886) p. 122.

|| *Geol. Mag.* n. s. dec. v. vol. ii. (1905) p. 195.

extent of the pulp-cavity, it is believed to have belonged to a nearly adult individual and indicates a tooth of small size, though its condition is too imperfect to admit of any measurements being given other than its approximate diameter, which is 46 mm.

*Upper Molars.*—Only two of the nine molars are considered to belong to the upper series; the smaller of these (M. 9376), a *first true molar*, is split longitudinally almost in half, but sufficient remains to show the general character of the tooth. It consists of seven plates, though it is possible that an additional small anterior ridge was originally present. Its antero-posterior length is 54 mm. and height about 32 mm., although the fangs extended for a short distance further, bringing the total measurement up to 41 mm. Comparatively speaking, the height of this tooth is slightly greater than in most of the other specimens referred to *E. creticus*; this is an argument in favour of its being a first true molar rather than the last of the milk-series, which, from its size alone, it might perhaps have been thought to represent. The enamel bands are not very thick and in several of the ridges are somewhat broken up into "rings"; at the same time, the cement-areas are broad, a character generally found in conjunction with more massive enamel. In section this tooth shows that the cement-areas maintain an almost uniform width for nearly the whole of their extent. This feature is probably not infrequent in the molars of this species, as suggestively exemplified by some of the extensively worn specimens described below.

The Cretan specimen is superior in antero posterior length to an example of the corresponding tooth of *E. cypriotes* (M. 8602)\*, though this latter exceeds it in the height of its crown, which is 53.5 mm.; this difference in the proportions is even more marked in a molar of *E. melitensis* (44252)†.

The second specimen (M. 9377, Pl. XIII. fig. 2), believed to belong to the upper series, is of larger proportions than the last, and is much worn and somewhat damaged; it probably represents the *penultimate true molar*. It is difficult to say of how many plates it originally consisted, but it can be seen that there were at least eight, all of which were in use, the front ones being worn down almost to their common base, while a portion of the anterior ridge is broken off. Partly owing to its advanced state of wear, the crown is very wide, being 37 mm. across, while its antero-posterior length is 77 mm. and its height 37 mm., though this would of course have been greater when the tooth was still but slightly abraded. In spite of the condition of this molar the cement-areas are still broad, equalling or even exceeding in size the plates of dentine; the enamel bands are thick and in a few instances somewhat wavy in outline.

Although apparently considerably superior in height of crown, this tooth in *E. cypriotes* is otherwise decidedly smaller than the above, the dimensions of a much less worn example (M. 8601)

\* Figured, Phil. Trans. vol. 197 B (1904), p. 351, pl. 21. figs. 4, 4 a.

† Trans. Zool. Soc. vol. ix. p. 20, pl. 2. figs. 9, 9 a.

being:—approximate antero-posterior length 72 mm., greatest width of crown 28 mm., and total height 65 mm. Compared with the specimen (49267)\* identified by Falconer as *M. 1* of *E. melitensis*, this last is somewhat narrower in the crown, which is 33 mm. across, though this may be partly accounted for by the difference in age, and it is likely that the two would originally have closely agreed in this respect. On the other hand, in height the molar from Malta greatly exceeds the one from Crete, being very high in relation to its width, as already noted by Falconer; further, the cement-areas in the Cretan fossil are distinctly broader.

*Lower Molars.* Of the seven molars obtained not one can be referred to a position among the milk-teeth, while, owing to imperfect preservation, it is impossible in one or two cases to make certain of the place originally occupied in the permanent series. The first true molar appears not to be represented. Two specimens, both belonging to the right side of the mandible, are believed to be *second true molars*. One (*M. 9378 a*) has been considerably weathered and is much worn, all except the last of the plates having been in use; the number of these was at least nine. The cement-areas are broad and the enamel bands thick and smooth, while in two, if not three, of them there is a median loop, though this is unaccompanied by a mesial expansion of the plates of dentine.

The other tooth (*M. 9378*, Pl. XIII. figs. 1, 1 *a*), regarded as a second true molar, is also extensively worn, the penultimate ridge being already slightly abraded; although it is broken off anteriorly seven plates remain as well as a portion of an eighth. The width of the seventh plate (counting from the rear) is 37 mm., while the height of the preantepenultimate one is only 33 mm.; the enamel is massive and in the four posterior used plates is somewhat irregular, while the cement separating the anterior ridges is considerably excavated. A comparison shows this Cretan specimen to be broader and much lower in the crown than a corresponding, though less worn, tooth of *E. cypriotes* (*M. 8588*)†.

Judging from their size it is probable that two other lower true molars, very imperfectly preserved, also represent the second of the permanent series. One of these (*M. 9382*) is situated in the posterior half of a left mandibular ramus; it probably consisted of eight or nine plates and, like most of the teeth obtained of *E. creticus*, is low-crowned and has thick enamel bands and wide cement-areas. The other example (*M. 9380*) is a portion of a much damaged right molar; the worn surfaces of two ridges remain and seem in no way to differ from those of the specimens already described.

The last lower molar (*M. 3*) is represented by three specimens, none of which is in an advanced stage of wear. Two of these,

\* Falconer, Pal. Mem. vol. ii. pl. 11. figs. 2, 2 *a*, p. 294: also identified by Bask as *M. 1* of *E. falconeri*, Trans. Zool. Soc. vol. vi. part v. pl. 53. figs. 8, 9 *a*.

† Phil. Trans. vol. 197 B (1904), p. 355, pl. 21. figs. 3, 3 *a*.

damaged anteriorly, are each situated in a portion of a ramus; and belonging, as they do, to opposite sides of the mandible as well as being in a similar stage of wear, it is thought that they may have been owned by a single individual. On the left side (M. 9383 *a*, Pl. XII. fig. 1), in addition to the last molar, the three posterior plates of M. 2 are also present. In M. 3 eleven plates can be counted, but a considerable part of the posterior portion of the tooth is wanting. The fifth plate is slightly abraded, and it is noticeable in both this and the companion specimen that the enveloping cement on the grinding-surface of the crown is somewhat scanty, with the result that all the enamel soon becomes exposed, even while the anterior portion of the tooth may still be but little worn. The second example (M. 9383 *b*) presents very similar characteristics; the presence of eleven plates can be determined, but damage anteriorly and concealment of the tooth behind by the bone and matrix make it impossible to ascertain the original total.

The one other last true molar (M. 9381, Pl. XII. fig. 3), an isolated tooth of the left side, is almost perfectly preserved except for the loss of the greater part of the first and a portion of the second plate. It is considerably curved, this being accentuated by the angle at which the hinder plates lie. The number of ridges is thirteen, six of which show signs of more or less wear, and there appears to be no evidence of the former presence of any additional ones. The sloping, instead of upright, position of the last plate is a further indication that this molar must be considered an example of the last of the permanent series. The antero-posterior length of the tooth (not along the curve) is about 122 mm., or 139 mm. if continued to the heel of its base; the greatest height, which occurs at the sixth plate, is 53 mm., while the width of the abraded surface of the third ridge is 35 mm. The cement-areas are of medium width and the enamel bands thick and uncrimped, though somewhat irregular and disconnected in the less-worn plates.

It is interesting to contrast this with two corresponding teeth of *E. cypristes* in the British Museum Collection\*, all three being of the left side and in practically a similar stage of use. The Cretan fossil is the more massive and superior in width and antero-posterior length, the persistence of the annulation of the enamel bands is also more strongly marked. On the other hand, it has a lower crown (53 mm.), both actually and as compared with its bulk, than the Cypriote specimens, this being 59 mm. in the isolated tooth (M. 8591), while in the other (M. 8589), although the ramus prevents a measurement of the greatest height being obtained, that of the seventh plate is 63 mm. The most satisfactorily identified last molar of *E. melitensis* in the British Museum Collection for comparison with the above-noticed tooth from Crete, is a specimen situated in a right mandibular

\* M. 8589, Phil. Trans. vol. 197 B (1904), p. 355, text-figs. 2 & 3; and M. 8591, *ibid.* p. 355, pl. 22. figs. 6, 6 *a*.

ramus (M. 44294), already described and figured by Dr. Leith Adams\*. It is evident that in antero-posterior length it slightly exceeds the Cretan example and consists of several more plates, these being in much closer proximity owing to the narrowness of the cement-areas and the less massive enamel bands. Considering the size of the ramus this tooth must be much the higher of the two, while in breadth of crown the molar from Crete is superior.

The one other dental specimen obtained (M. 9379, Pl. XII. fig. 2) consists of only three unworn plates; the anterior surface of the foremost of these is strongly but simply grooved, its greatest width is 35 mm. and its height 50 mm.

The only bone procured from the deposit near Cape Maleka is the dorsal half of a vertebra embedded in the matrix attached to the mandibular ramus containing a last true molar (M. 9383).

From this brief account of the remains procured of *E. creticus*, it will be seen that this pigmy Elephant must have been of slightly larger proportions than *E. cypriotes* and approached in size more closely to *E. melitensis*; that is to say, it would have attained as a maximum a height of five feet†. All the molars obtained differ from those of the two last-named dwarf species in being much lower in the crown; this is perhaps the most noticeable feature of the series. At the same time the teeth are wide, the cement-areas broad, and the enamel simple, though at times broken up into a number of rings. So far as can be ascertained from the scanty amount of material the ridge-formula must have been low.

Except with regard to the immense difference in size the characteristics of the molars described above, more especially in the lowness of the crowns‡, appear to resemble more closely those of *E. meridionalis* than of any other of the larger Elephants of the Mediterranean Region.

## II. ELEPHAS ANTIQUS Falconer.

As previously mentioned, remains of this Elephant § had already been obtained from caves close to Retymno. The teeth and bones noted below, and believed to belong to this species, were all procured from a much damaged and fragmentary cave-deposit, one of several found close together in the cliffs bordering the south of Kharoumes Bay in the Eparkhia of Sitæa||. Although evidently but a remnant of a formerly larger deposit, it was possible

\* Trans. Zool. Soc. vol. ix. p. 30, pl. 6. figs. 1, 1 a.

† Leith Adams, Trans. Zool. Soc. vol. ix. pp. 108, 116.

‡ This characteristic of the molars of *E. meridionalis* was constantly noted by Falconer, see Pal. Mem. (London, 1868), vol. ii. pp. 128, 134, 138, &c.

§ Signor Simonelli does not give the author of his *E. priscus*, but it may be supposed that this name is employed for the thick-ridged variety of *E. antiquus* (Falconer's *E. priscus*, Cat. Foss. Mamm. Brit. Mus. part iv. p. 122), since the name *E. priscus* of Goldfuss appears to have been applied to molars almost indistinguishable from those of *E. africanus* (see Pomel, Bull. Soc. Géol. France, tome vii. 1878, p. 51).

|| Geol. Mag. n. s. dec. v. vol. ii. (1905), footnote 3, p. 199.

to trace the presence of Elephant bones for a depth of several feet. Some few remains of ruminants, similar to those found in other parts of the island, also occurred here, but were only observed close to the uppermost of the bones of the Proboscidian, which probably became extinct long before these smaller mammals.

It has already been mentioned elsewhere\* that in another cave-deposit, on the same level—that is to say, not many feet above the sea, and only a few yards distant from the one under discussion,—were found a number of land-shells, *Helix pellita* Fér., a species seemingly not previously recorded in a fossil state†, these being preserved in the hard red breccia so common in cave-deposits. The presence of these shells points conclusively to the deposition of the mammalian remains under land-conditions, though it now appears just possible that these deposits were subsequently at all events partially submerged, which may help to account for their fragmentary condition. The occurrence of this movement is suggested by the discovery, in some sand adhering to a femur of *E. antiquus*, of a large number of foraminifera and other marine forms, an account and list of which have been published by the Rev. R. Ashington Bullen‡. Traces of a former submergence are more noticeable in the west of the island, especially at Sphinari and the Kutri and Haghios Basilis caves; it was also unexpected in the east, where the coastal movement is supposed to have been for long past in an opposite direction to that in the west§.

*E. antiquus* is represented by a number of limb-bones, including several perfectly preserved foot-bones, and a single right mandibular ramus (M. 9384) containing two somewhat damaged molars. Both from its size and from the fact of its having been found situated just above the limb-bones, it was at first sight thought that this last indicated the former occurrence in Crete of a small race of Elephant intermediate in size between the pigmy *E. creticus* and the very large species indicated by the remains noticed below. However, a further study of the material has caused the conclusion to be reached that it is a portion of the mandibular ramus of an immature specimen of *E. antiquus*, and that the teeth must be the penultimate and ultimate milk-molars, or perhaps the last of the milk and first of the permanent series. The general appearance and characters of these molars support this view of their identity, which is further strengthened by the fact of the large limb-bones occurring in the same deposit, and also that *E. antiquus* has already been recorded from another district of the island.

*Lower Molars.*—As already remarked, the two lower molars obtained, and believed to be those of *E. antiquus*, are situated in a portion of the right mandibular ramus shown in text-fig. 83 and Pl. XIII. fig. 3: neither of these teeth is quite complete.

\* Geol. Mag. n. s. dec. v. vol. ii. 1905, footnote 2, p. 199; and Rev. R. Ashington Bullen, Proc. Malacol. Soc. vol. vi., Sept. 1905, p. 307.

† *Ibid.*

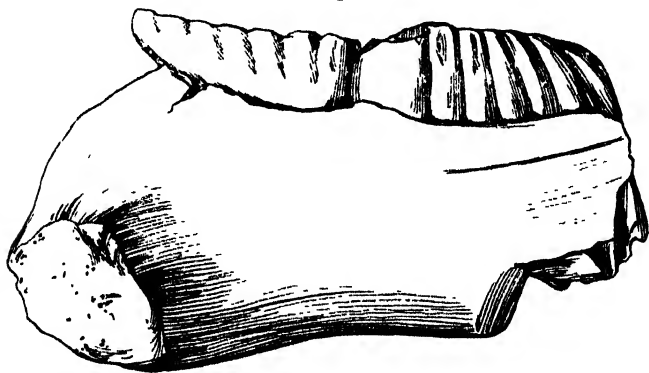
‡ Geol. Mag. n. s. dec. v. vol. iii. pp. 353-358, pls. 18 & 19.

§ For references to this, see Geol. Mag. n. s. dec. v. vol. ii. (1905), footnotes 2 & 3, p. 197.

The whole specimen is about 263 mm. (nearly 10½ inches) in length; the ramus is robust, the greatest thickness in the portion preserved being 112 mm., and its depth, measured in front of the first molar, is about 126 mm. Its anterior border is very abrupt owing to the advanced state of wear and consequent forward position of the anterior of the two teeth.

Unfortunately neither of these molars retains its full complement of plates, which makes it impossible to determine with absolute certainty their exact position in the series, for, as may be seen by the specimens in the British Museum Collection, and has been pointed out by Dr. Leith Adams\*, the milk-teeth of this species varied in size to a very great extent. However, it seems certain that the specimens in question represent either the two last milk-molars or the posterior of these and the first true molar.

Text-fig. 83.



Right mandibular ramus of *Elephas antiquus* (?) bearing two lower molars.  
½ nat. size.

The actual height of the foremost tooth (Pl. XIII. fig. 3 and text-fig. 83) is not shown, owing to the enveloping ramus; it consists of eight plates, but is extensively worn and projects considerably beyond the edge of the alveolus, so it is likely that there may have been one, perhaps two, additional plates originally. The present length of the crown, measuring along the median line of the plates, is 92 mm., and its greatest width, which occurs at the sixth of the plates present, is 47 mm., its height above the ramus at the same place is 30 mm. The cement-areas are not so wide as those of the following molar, but this is probably due to difference in wear; in neither is there any mesial expansion of the plates. The enamel bands are rather thin and "wavy" in outline, in both these respects differing from the specimens from Cape Maleka.

The second of the two teeth also shows eight plates, though it

\* Mon. Brit. Fossil Elephants, Pal. Soc. London, 1877.



is evident that one or more may be wanting posteriorly. Only the anterior five are worn, and the enamel is seen to be less irregular than in the preceding molar, considerable digitation of the plates is observable, while the cement-areas are of considerable width. This molar is remarkable for its very great height, being 103 mm., while the greatest width of the crown at the second plate is only 43 mm. It will be remembered that this was given by Falconer\* as one of the distinguishing characteristics of the molars of *E. antiquus*:—"Great height of the plates. The height is more than double the width of the crown." This is in striking contrast to the proportions of the teeth of *E. creticus*, in some examples of which the height of the crown is exceeded by its width. Particularly in the rather thin and very wavy outline of the enamel bands, these specimens from the Kharoumes deposit resemble a number of those of *E. mnaidriensis* figured by Dr. Leith Adams†, who also called attention to the resemblance between the molars of this Maltese species and those of *E. antiquus*‡.

*Limb-bones*.—The specific or peculiar characters of the limb bones of *E. antiquus* do not appear to be well known, partly no doubt owing to the difficulty of distinguishing them in cases where the remains of more than one species of similar size occur in a single deposit, so that it is evidently chiefly by inference that the fragmentary collection of bones under discussion must be determined as those of this species. However, it will have to be acknowledged that this contention is a strong one when we consider the identity of the teeth found in the same deposit, and the discovery of the cave near Retymno from which were obtained similar, though more complete, remains. At least two individuals are represented amongst the limb-bones, which number about twenty and are almost all imperfect, with the exception of a few foot-bones; and in many cases the articular surfaces are damaged or missing, which makes it difficult to discern any features other than that of size. Nearly every specimen was covered with a thin red stalagmitic encrustation.

The only portion of the *spinal column* procured is a portion of the neural arch of a dorsal vertebra (M. 9388). The collection contains two *ulnae* (M. 9385), though only the proximal portion of each is preserved. One of these, which is unfortunately much crushed, is of the right side and apparently that of an adult. It seems to agree in size and general appearance with a corresponding bone of *E. antiquus* in the British Museum Collection (45203)§. A fragment of the *humerus* is still attached to the second specimen, which belongs to the left side and is that of a young individual, the line of junction between the shaft and the olecranon epiphysis being very apparent. On comparing it with the proximal portion of a left ulna in the Collection of the British Museum (45202)||,

\* Pal. Mem. vol. ii. p. 176.

† Trans. Zool. Soc. vol. ix.

‡ Mon. Brit. Fossil Elephants, Pal. Soc. 1877, pp. 25 & 50.

§ *Ibid.* p. 59, D. 12.

|| *Ibid.*

it appears that the depression below and between the olecranon and the projection of the sigmoid notch is more extensive in the former, and also that the distance between the coronoid process and the olecranon is comparatively greater.

An imperfectly preserved left *femur*, with its distal extremity missing, was obtained, also the head of another and a fragment of the head of a third. The entire length of the former is 29 inches (89 mm.); it is decidedly short in the neck and has a shallow digital pit, both of which characters are claimed for *E. antiquus* by Dr. Leith Adams\*, as well as for *E. namalicus*†, *E. africanus*, and *E. mnaidriensis*.

A left *cuneiform*, which is attached to the unciform, is very much larger than a corresponding bone in the British Museum Collection (36608)‡, which, however, is by no means a large example for this species. The greatest width of the Cretan specimen, from its inner border to the outer angle, is 165 mm., while antero-posteriorly it measures 115 mm., though this would be slightly more were it quite intact. The height of its anterior face is 57 mm. The greatest height of the anterior face of the above-mentioned *unciform* is 81 mm., antero-posteriorly it is 125 mm., and from side to side 151 mm. A considerably damaged right unciform appears to be of similar proportions.

An almost perfect right *trapezium* included in the collection is found to differ considerably in size and outline from the one figured by Dr. Leith Adams, and considered by him to present diagnostic characters§. The former is altogether much smaller and slighter than the latter, its greatest height, taken perpendicularly, being 79 mm., and its circumference just below the external articular surface 180 mm. In the British Museum specimen the lower articular surface|| is expanded and almost oval in shape, whilst in the one from Crete this is narrower and somewhat elongated. The projection beyond the anterior border of the distal articular surface is extremely pronounced, and it is chiefly to this that the bone owes its irregular outline.

The *metacarpals* are represented by two distal extremities and an almost perfect specimen of the fifth metacarpal of the left manus. Its exterior border is 142 mm., the proximal articular surfaces measure 83 mm. from inner to outer edge, while antero-posteriorly they are about 78 mm., the circumference at the centre of the shaft is approximately 210 mm.

The proximal phalanx of the fifth digit of the right manus, another digital phalanx, an imperfect right semilunar, and some portions of ribs, are the only other well-preserved remains of *E. antiquus* obtained.

\* Mon. British Fossil Elephants, p. 63.

† Considered by some writers as a variety of or identical with *E. antiquus* (see G. E. Pilgrim, Records Geol. Survey India, vol. xxxii. part 3, pp. 204, 205, 215, &c.).

‡ Cat. Foss. Mamm. Brit. Mus. part iv. p. 136.

§ Op. cit. pp. 180 & 234, pl. 19. figs. 9-9 B, B.M. 20821.

|| *Ibid.* fig. 9 B.

## III. CONCLUSIONS.

It was at one time thought that the discovery of remains of different Elephants in the Pleistocene cave-deposits of Crete might help to throw additional, or perhaps even fresh, light on the subject of the origin and development of pigmy forms. However, it will have been seen from the above descriptions that the material obtained is very fragmentary, so that little more than the identity of the species can be established, though there is at least sufficient to suggest one or two minor problems of some considerable interest.

The occurrence of two species of Elephant in more or less contemporary deposits in such a comparatively restricted area as Crete hints at, though by no means proves, the likelihood of some possible relationship or connection between them. It seems quite certain that Crete, even if well covered with a luxuriant vegetation, could not support for long an Elephant of such great size as *E. antiquus*, so it is probable that this large race, at all events as such, ceased to exist in early Pleistocene times, which would be tantamount to saying shortly after the separation of the island from the mainland.

It seems a firmly established and well-supported theory that the dwarf proportions of the pigmy species found in most of the larger Mediterranean islands are a specialised character acquired to meet the exigencies of these island habitats; for, as M. Gaudry has remarked\*, these former small races have confirmed the idea that the size of animals was in accordance with the extent of their habitat. Among other arguments, if needed, in favour of this is the fact that up to the present no similar remains of a small form are known to occur in deposits earlier than Pleistocene. In this connection further information with regard to the extent and cause of the dwarfing of *E. africanus pumilio* Noack†, from the French Congo, will be of the utmost interest, and might also help to elucidate the problem of the possibly analogous *Hippopotamus liberiensis*.

Nowadays many writers maintain that *E. antiquus* is the parent form of the hitherto described pigmies of the Mediterranean area, and this seems to have been well established by Prof. Pohlig‡ in the case of the remains from Sicily. At first sight the idea that these tiny forms were all derived from one of the largest species of the genus appears to be a somewhat startling one, but may it not be that the attainment of such dimensions under favourable circumstances points to the species having been one highly susceptible to and strongly acted upon by its environment and conditions of life? If so, the same would apply under opposite conditions, adverse circumstances causing a rapid diminution in size; for, as

\* "Ont confirmé l'idée que la taille des animaux était en rapport avec l'étendue de leur habitat" 'Foss. de Patagonie,' Ann. de Paléontologie, tome i. fasc. iii., Juin 1906, p. 8.

† Zool. Anzeiger, Bd. xxix. No. 20, Jan. 1906.

‡ Abh. d. k.-bay. Akad. Wiss. xviii., and Nov. Act. L.-C. Akad. Naturforsch. lvii.

Mr. Pilgrim has remarked\*, it is to this adaptability that *E. antiquus* owed its wide geographical distribution and also its continued existence through a long period of time.

Therefore, allowing that *E. creticus* is a dwarfed species, the question of descent is decidedly the most interesting point raised by this newly discovered pigmy of Crete. Two alternative theories with regard to this subject suggest themselves :—

- A. That, taking into consideration the several points of resemblance, which may prove to be only superficial, between the molars of *E. creticus* and *E. meridionalis*, the latter may be the parent form, in which case it must have inhabited Crete contemporaneously with *E. antiquus*.
- B. That the Cretan race is descended from *E. antiquus*, which we think is most likely to prove the true solution of the question. Some few points which appear to support this may be noted here. Among these are the fact of remains of this large species being found in the island and the evidence which tends to show a similar ancestry for other island races of the same region.

Supposing *E. creticus* to be derived from *E. antiquus*, this would necessarily mean that the former became differentiated since early Pleistocene times. That this calculation would allow ample time for such a change to be accomplished seems probable, when it is considered that *E. cypriotes* was the result of isolation for a no longer period, since, according to Messrs. Bellamy and Jukes-Browne †, it seems that a land-connection existed between Cyprus and the mainland as late as the beginning of the Pleistocene era.

Both from the geological evidence and from the apparently still plastic condition of the small Elephants of Malta, as well as of the Hippopotamus of Sicily, at the time of their extinction, it is likely that these islands, more particularly the latter, have formed areas of isolation for an even shorter term than Cyprus. Therefore it would have been vital to the continued existence of the species that the dwarfing should be accomplished as rapidly as possible; this also applies to the molars, in which the result might have been attained by diminishing the height and number of the plates, thus apparently to a certain extent reverting to a more simple condition. A significant fact which may lend weight to this suggestion is that, although *E. mnaidriensis* and *E. melitensis* of Malta are seemingly closely connected and probably represent two stages in the evolution of a pigmy from a large Elephant, yet the latter has the lower ridge-formula ‡, although it is the smaller and therefore, in that direction, the more specialised of the two.

My sincere thanks are due to Dr. A. Smith Woodward, F.R.S.,

\* Records Geol. Survey India, vol. xxxii. pt. 3, p. 216.

† 'The Geology of Cyprus,' chap. viii. (Plymouth, 1905); and Bellamy, Key to Geol. Map Cyprus, pp. 15, 16 (Stanford, 1905).

‡ Lydekker, Cat. Foss. Mamm. Brit. Mus. part iv. p. 161.

for giving me every facility for working in his department of the British Museum (Nat. Hist.).

### EXPLANATION OF THE PLATES.

#### PLATE XII.

- Fig. 1. Inner side of the posterior part of the second and anterior part of the third right lower molars of *Elephas creticus*. (M. 9383 a.)  $\frac{3}{4}$  nat. size.  
 2. Unworn plates of a molar of *E. creticus*. (M. 9379.) Nat. size.  
 3. Crown view of right lower third molar of *E. creticus*. (M. 9381.)  $\frac{3}{4}$  nat. size.

#### PLATE XIII.

- Fig. 1. Crown and (1 a) side views of second lower molar of *E. creticus*. (M. 9378.)  $\frac{3}{4}$  nat. size.  
 2. Crown view of second upper molar of *E. creticus*. One of the plates has been restored. (M. 9377.)  $\frac{3}{4}$  nat. size.  
 3. Crown view of the first and second right lower molars (or last milk-molar and first molar) of *Elephas antiquus* Falconer. (M. 9384.)  $\frac{3}{4}$  nat. size.  
 (The numbers of the specimens are those in the British Museum register.)


### 3. Zoological Results of the Third Tanganyika Expedition, conducted by Dr. W. A. Cunningham, 1904-1905.—Report on the Polyzoa. By CHARLES F. ROUSSELET, F.R.M.S.

[Received February 2, 1907.]

(Plates XIV. & XV.\*)

The freshwater Polyzoa collected in Lake Tanganyika by Dr. W. A. Cunningham are attached to stones and shells which were partly obtained in shallow water and partly dredged from 20 to 40 fathoms.

Altogether the collection contains five species, three of which belong to the Phylactolamata and two to the Gymnolamata. Amongst the latter is Moore's *Arachnoidia ray-lankesteri* (10†), which was found in some abundance on shells of *Paramelania* dredged from deep water.

Two species of the Phylactolamata are of the *Plumatella* type, with horseshoe-shaped lophophore. One of these appears to be a new species, very closely adherent to stones, with half-formed -shaped tubes, which I have named *Plumatella tanganyikæ*.

To the second species I have given no name, as the few fragments of tubes and the total absence of statoblasts offer no characters that would distinguish it from *Plumatella repens*.

The third Phylactolamatus specimen is an interesting new species of the genus *Fredericella*, which I have named *Fredericella cunningtoni* in honour of its discoverer, who dredged it from 25 fathoms near Mshale.

The second of the Gymnolamatus species is of special interest, as being always found associated with, and imbedded in, a fresh-

\* For explanation of the Plates, see p. 257.

† The numbers refer to the Bibliography, pp. 256, 257.

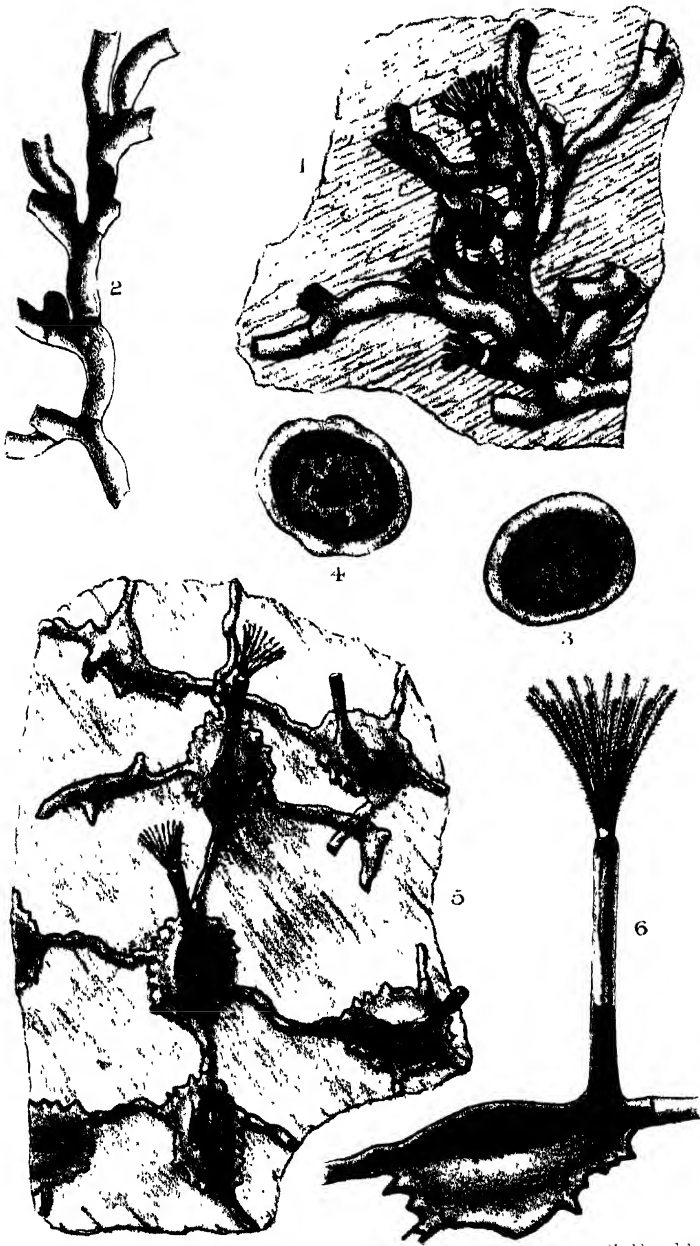


Fig. G. & R. Dixon-Nuttall del.

Highley, del. scilicet

TANGANYIKA POLYZOA.



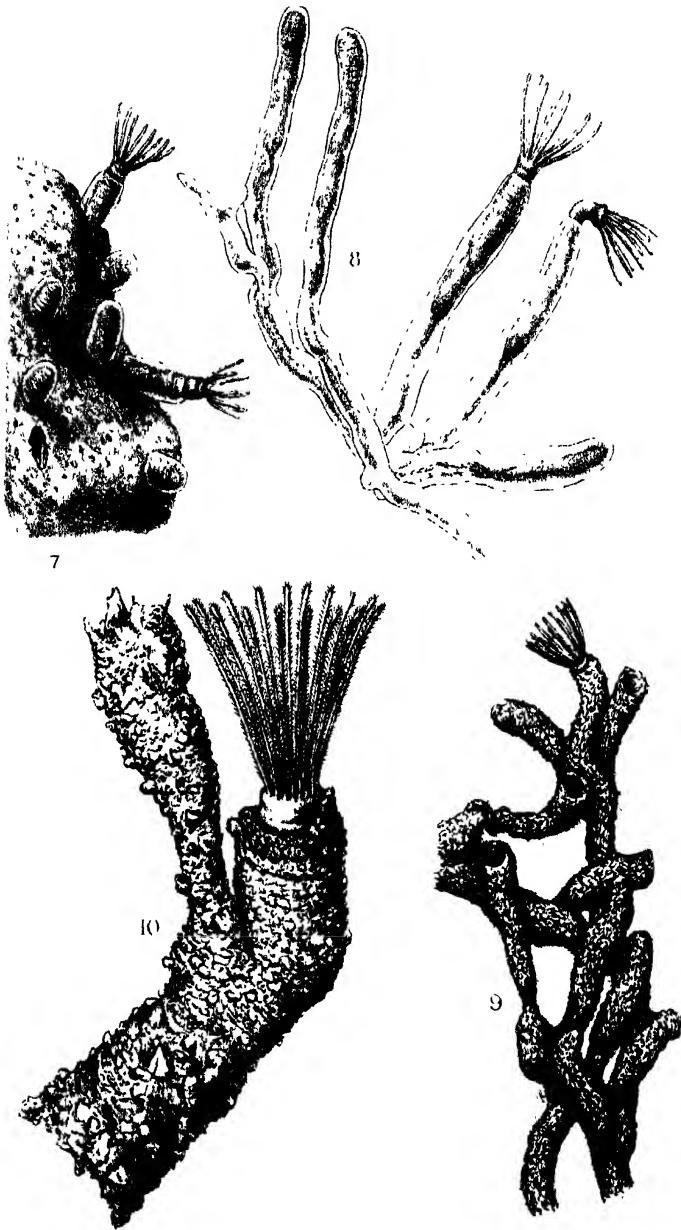


Fig 10. F R Dixon Nuttall del

Highley, del et lith





water sponge, *Spongilla tanganyikæ* Evans, only the small heads projecting beyond the surface of the sponge. Its affinities appear to approach nearest to *Victorella*, and I have therefore named it *Victorella symbiotica*.

The following is a list of the five species here described :—

1. *Plumatella tanganyikæ*, sp. n.
2. „ *repens*, var. †
3. *Fredericella cunningtoni*, sp. n.
4. *Arachnoidia ray-lankesteri* Moore.
5. *Victorella symbiotica*, sp. n.

The number of known species of Polyzoa inhabiting African fresh waters is thus brought up to eight, truly a remarkably small number for this vast continent.

The other African species so far recorded are the following :—

*Fredericella sultana*, found by Dr. Stuhlmann in Alexandria, Egypt (7), and in the Equefa River, Natal, by the Hon. Thos. Kirkman \*.

*Plumatella repens*, var., from Ugogo, Victoria Nyanza, Albert Edward Nyanza, and Albert Nyanza : the statoblasts only found by Dr. Stuhlmann (7) and also by Dr. Meissner on shells of *Etheria* (in the Berlin Museum) from the Upper Nile, White Nile, the Niger, and Senegal (8, 9).

*Lophopodella (Pectinatella) carteri* Hyatt, from Ugogo : statoblasts found by Dr. Stuhlmann (7).

*Lophopodella thomasi* Rouss., from Hunyani River, Rhodesia (12).

The indifferent preservation of the Tanganyika specimens has unfortunately hampered and prevented a complete study of all the species. They were narcotised with cocaine and then preserved in alcohol, which is not a sufficiently good fixative for these animals. Freshwater Polyzoa must not be allowed to die in the anæsthetic, which quickly macerates their delicate bodies. After treatment with cocaine in perfectly clean water they should be killed and fixed whilst still living, either with very weak osmic acid ( $\frac{1}{10}$  per cent.) for ten minutes to half an hour, according to the age and actual strength of the solution, then washed, and also preserved, in 3 per cent. commercial formalin (97 c.c. water, 3 c.c. formalin); or else fixed with a 10 per cent. solution of formalin (90 c.c. water, 10 c.c. formalin) for 24 hours, then preserved in 3 per cent. formalin to which  $\frac{1}{2}$  per cent. glycerine may be added to render the animals more transparent. Polyzoa fixed with osmic acid are stained brown, or even black, if allowed to stay too long in the fixative; those fixed with formalin remain white and transparent.

The little bottles in which the preserved specimens are stored should have no air-space; an air-bubble plays havoc with the delicate tentacles of extended polypides.

\* Mentioned in his paper on the Rotifera of Natal as supporting tubes of *Limnias ceratophylli*: Journ. Roy. Micr. Soc. 1901, p. 232.

With regard to the question of the origin of the freshwater Polyzoa, I am inclined to agree with Dr. Wesenberg-Lund (13), who has expressed the view that all the different groups have wandered from the sea, the Phylactolemata at an early period, so that their marine ancestors are not now known, and may have become extinct in the sea long ages ago, whilst the freshwater Gymnolemata, i. e. *Paludicella*, *Victorella*, *Pottsiella*, *Arachnoidia*, have immigrated at a much later period, so that they still show some affinity with several marine genera.

If this conception be correct, it follows that there can be no relationship between the living Phylactolemata and Gymnolemata, and still less can there be intermediate forms connecting the one with the other.

In June of last year I succeeded, with the kind assistance of Dr. Bousfield, in again finding *Victorella parida* in the Surrey Canal, London, where it had been obtained some twenty years ago, but not recorded since. A study of this species and of the other known freshwater Gymnolemata has impressed upon me that, in addition to the absence of statoblasts, they are all possessed of a common character of considerable importance, which they share with a group of marine Ctenostomata, and which may well denote a certain degree of affinity. In all these forms there is a stolon which expands into a cell or zoecium, at the upper end of which an orifice is formed which may become enlarged into an elongated, more or less cylindrical tube for the protrusion of the polypide. Behind the orifice the stolon, after forming a septum, continues to grow out to form another cell a little further on; then on each side of the cell normally one additional stolon arises, also separated by a septum, to form new branches, which repeat the same process of cell-formation until the growing point of the stolon is either broken off or becomes atrophied. In this way a zoarium is produced, forming an irregular network of branches, approximately at right angles to each other. This cruciform mode of growth can readily be observed in all the species of the following genera, which might be grouped together under the name of "Cruciform Stolonifera":—

<i>Paludicella.</i>	}	Freshwater.
<i>Victorella.</i>		
<i>Pottsiella.</i>		
<i>Arachnoidia.</i>		
<i>Arachnidium.</i>	}	Marine*.
<i>Cylindroecium.</i>		


*PLUMATELLA TANGANYIKÆ*, sp. n. (Plate XIV. figs. 1-4.)

*Specific Characters.*—Zoarium consisting of clear light brown chitinous tubes, branching, curving, and interlacing, closely

\* The marine species *Barentsia misakiensis* from Japan, described by Dr. A. Oka in 1895, shows the same fundamental structure.

adherent, encrusting stones, in the substance of which they are partly embedded; also encrusting shells of molluscs; tubes sometimes flat-sided. Tentacles about 20. Sessile statoblasts oval; floating statoblasts not observed.

The appearance of this new *Plumatella* is very different from the European species and varieties of the genus, as will be seen by figs. 1 & 2, Pl. XIV.

The tubes form a thin, closely adherent, interlacing, encrusting layer, and are partly embedded in the stone on which they grow; or, possibly, stony crystalline material has been deposited in between and over the tubes. The tubes encrusting stones are fairly tubular, but those encrusting molluscan shells are flat-sided or -shaped in section, and the adhering side has only a very thin layer of chitinous material, so that the supporting shell is used by the animal to form part of its protecting tube. The tubes are of a light brown colour, clear and nearly transparent. The raised ends of the tubes are always tubular and white. Septa are present in the tubes at the points of branching.

A full and well-extended head was not found; but there is every appearance that the lophophore is horseshoe-shaped, with about 20 tentacles.

Sessile statoblasts were found in the tubes (Pl. XIV. figs. 3 & 4); they are oval in shape, but varying a good deal in their proportions of width to length, smooth, and surrounded by a thin, narrow, flat annulus without air-cells; their greatest size is: length  $450\ \mu$  ( $\frac{1}{58}$  in.), width  $343\ \mu$  ( $\frac{1}{71}$  in.). Ordinary floating statoblasts with swimming annulus were not observed.

Diameter of tubes  $321\ \mu$  ( $\frac{1}{9}$  in.) on average.

*Habitat.* Encrusting stones just below water-level at Kalambo and Kassangu; and also encrusting shells in shallow water at Chamkuluki.

#### PLUMATELLA REPENS, var. ?

This specimen was found attached to shells of living *Tiphobia*, dredged from about 40 fathoms at Maswa.

The tubes are brown in colour, semi-opaque, and show a deposit of fine material in more or less regular longitudinal or transverse lines; they are partly adherent, branching irregularly, tubular, and altogether have much resemblance to those of *Plumatella repens* of our lakes and canals, from which it is hardly possible to differentiate them.


Fully extended specimens were not present, but the lophophore appears to have about 22 to 24 tentacles.

The diameter of the tubes is  $364\ \mu$  ( $\frac{1}{9}$  in.) on average.

Some sessile statoblasts found in the tubes are oval, smooth, with thin flat annulus without air-cells,  $407\ \mu$  ( $\frac{1}{82}$  in.) in length and  $278\ \mu$  ( $\frac{1}{71}$  in.) in width. Floating statoblasts with cellular annulus were not observed.



The tubes are larger, and the sessile statoblasts smaller and more elongated, than in the preceding species.

**FREDERICELLA CUNNINGTONI, sp. n.** (Plate XV. figs. 9 & 10.)

*Specific Characters*.—Zoarium consisting of creeping, closely adherent, branching and interlacing -shaped tubes, built of a very thin, transparent, chitinous, internal membrane, covered externally with coarse grains of sand; lophophore circular, with 16 tentacles.

The appearance of the tubes of this new species is such that they were at first passed over as apparently the tubes of some aquatic worm or insect larva, until a circular lophophore was observed protruding from one of the tubes, when a closer examination, and the removal of the adhering tubes, revealed an abnormal Polyzoon.

Though the indifferent preservation of the specimens did not allow me to ascertain with certainty whether an epistome is present or not, all the other characters are those of a phylactolæmatous Polyzoon; and as the lophophore is circular, the genus *Fredericella* naturally suggested itself.

The tube is low and -shaped in section, very closely adherent to the surface of shells and stones, branching and interlacing freely. The structure of the tube is very abnormal; it consists of a very thin, transparent, chitinous layer, to the external surface of which grains of sand of various sizes and colour are cemented, not unlike the tubes of some marine worms. The grains of sand are mostly angular white quartz, and, to a less extent, green olivine, interspersed with red and black grains, and occasionally some plant and shell fragments. A few specimens show tubes made of finer sand-grains. Only the raised ends of tubes are tubular, otherwise the whole of the creeping tube is -shaped, the adhering surface being free from grains of sand. The cells of the polypides are long, continuous, and with a few incomplete septa here and there. The width of the tubes is  $346\ \mu$  ( $\frac{1}{4}$  in.) on an average.

The lophophore is circular and has 16 tentacles, but the rest of the anatomy could not be made out, owing to the bad state of preservation. No statoblasts were found in the tubes.

*Hab.* Encrusting stones and *Neothauma* shells dredged in about 10 fathoms at Kibanga, and also shells dredged in about 25 fathoms near Mshale.

The genus *Fredericella* has contained, so far, only one species, i. e. *F. sultana* of world-wide distribution, if we consider the three American forms *F. regina*, *walkottii*, and *pulcherrima* as synonyms of *F. sultana*, in accordance with the opinion of all recent authorities. *F. duplessisi*, found by Dr. F. A. Forel (2, 3, 4) living unattached in the soft mud at the bottom of the Lake of Geneva, also is but a *F. sultana* which has adapted itself to its environment. Having examined specimens dredged by Dr. Forel, consisting of short tubes with few branches, not exceeding half an inch in length, I can find no difference between them and the type species. I should like to mention here that I find the tubes of *F. sultana* rarely cylindrical, as has usually been

stated; much more frequently they are distinctly angular, and mostly triangular in shape.

*ARACHNOIDIA RAY-LANKESTERI* Moore. (Plate XIV. figs. 5 & 6.)

In his book 'The Tanganyika Problem,' 1903, Mr. J. E. S. Moore (10) mentions on p. 295 a gymmolæmatous Polyzoan found by him on shells of *Paramelaniu* dredged from about 20 fathoms off the shore of the lake, to which he gave the above name, considering it allied to the marine genus *Arachnidium*.

This interesting species has been found again by Dr. Cunningham, also on shells dredged from 20 to 25 fathoms near Mshale. The colonies form an encrusting network, consisting of ovoid or irregular, membranous, brownish cells, with toothed edges, closely adherent to the shell, and connected together by narrow, tubular, creeping stolons. The cells or zoecia are very flat and shallow, and have at their upper end a tall erect tube from which the polypides protrude. The lophophore is circular, without calyx, and has 16 narrow tentacles. A septum can be seen at the origin of each stolon.

In retraction the polypide retreats down the erect tube into the cell, invaginating in the process the anterior thin-walled part of the tube, which is the tentacle-sheath or kumptoderm. All that can be perceived within the shallow cell is a band of retractor muscles, and a sac filled with granules, possibly the stomach.

This species belongs to the group of Gymmolæmata which I have called "Cruciform Stolonifera," and certainly appears closely allied to the marine genus *Arachnidium*.

Its mode of growth appears to be as follows:—A narrow, filiform, closely adherent stolon, following all the irregularities of the surface of the shell, expands to form an ovoid cell, the edges of which are more or less toothed, the better to fit the depressions and ridges of the shell-surface. At the upper end of the cell an orifice is formed which elongates into an erect tube, whilst behind the orifice the stolon, after forming a septum, continues to grow to form another cell at some distance further on. At an early stage of the formation of the cells, stolons can be seen growing out laterally, one on each side, rarely more, to form side branches, and thus a very irregular cruciform network is formed. The cells are always well separated from each other by a stolon, and when found agglomerated together, as in Mr. Moore's rough sketch, it is the result of two or more colonies having grown over and in between each other.

Of the polypide the indifferent preservation does not allow me to say more than that the lophophore has 16 narrow tentacles.

The size of the largest cell seen is  $792\ \mu$  ( $\frac{1}{32}$  in.); width of stolon  $69\ \mu$  ( $\frac{1}{370}$  in.); length of the tube when the animal is protruded  $970\ \mu$  ( $\frac{1}{28}$  in.).

*VICTORELLA SYMBIOTICA*, sp. n. (Plate XV. figs. 7 & 8.)

*Specific Characters*.—Zoarium a narrow, tubular stolon with  
18\*

slightly expanded portions at intervals, from which a long erect tube rises; side branches arise at the base of the zoecia. Polypides with circular lophophore of 8 tentacles. The whole zoarium and zoecia embedded in *Spongilla tanganyikæ*, on the surface of which the polypides protrude.

The freshwater sponges brought back by Dr. Cunningham from Lake Tanganyika include specimens of *Spongilla tanganyikæ* Evans, in which was found embedded this gymnolæmatous polyzoon which cannot be identified with any known species. Its affinities seem to lie between the genera *Cylindrocium*, *Pottsiella*, and *Victorella*; but its habitat in freshwater and the number of tentacles possessed by the polypides, have decided me to place it in the last-named genus.

Potts's *Paludicella erecta* (11), afterwards renamed *Pottsiella erecta* by Prof. Kraepelin (6), is the only other freshwater species which is known to penetrate encrusting sponges, but its circular lophophore has 20 tentacles.

The meandering cylindrical stolons, glassy white when cleared from adhering sponge-fragments, form an entangled mass difficult to follow, and are entirely embedded in the substance of the sponge. Adjoining and crossing stolons and tubes adhere, but can be separated by tearing apart. No septa have been observed in the stolons.

The upright tubes, together with the slight expansions of the stolon, form the cell or zoecia, and lateral branches, one on each side, were observed springing from the expanded stolon, but these side branches are not always present.

The tubes are long, erect, single, slightly widened at the base, of glassy transparency, except the small portion above the surface, which is rendered more or less opaque by fine granules, and emerge on the surface of the sponge where the polypides expand their small circular lophophore of 8 tentacles. The length of the tubes in this species is no doubt due to the necessity of reaching to the surface of the sponge. In *Victorella pavida* of Kent (1, 5) the cell is formed by a very distinct expansion of the stolon and the tube arising therefrom is of moderate length. Length of erect tubes up to 1.7 mm. ( $\frac{1}{15}$  in.).

It has been a matter of considerable difficulty to dig the complete stolon with the tubes out of the substance of the sponge without breaking up these delicate structures, and the operation has been only partially successful.

*Hab.* Growing within and through specimens of *Spongilla tanganyikæ*, which were found encrusting rocks in shallow water at Chamkaluki, and also on shells dredged from about 20 fathoms near Mshale.

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## EXPLANATION OF THE PLATES.

## PLATE XIV.

- Fig. 1. *Plumatella tanganyikæ* (p. 252). Portion of interlacing tubes.  $\times 15$ .  
 2. *Plumatella tanganyikæ*. Flat under surface of tubes detached from shell, showing septa.  $\times 15$ .  
 3. *Plumatella tanganyikæ*. Sessile statoblast, upper surface.  $\times 50$ .  
 4. *Plumatella tanganyikæ*. The same, under surface.  $\times 50$ .  
 5. *Arachnoidia ray-lankesteri* (p. 255). Colony growing on shell.  $\times 20$ .  
 6. *Arachnoidia ray-lankesteri*. Single cell and polypide.  $\times 60$ .

## PLATE XV.

- Fig. 7. *Victorella symbiotica* (p. 255). Piece of sponge with polypides protruding on surface.  $\times 20$ .  
 8. *Victorella symbiotica*. Cells and stolon separated from sponge.  $\times 20$ .  
 9. *Fredericella cunningtoni* (p. 254). Interlacing tubes adhering to shell surface.  $\times 15$ .  
 10. *Fredericella cunningtoni*. Portion of same with protruding polypide.  $\times 56$ .



4. Zoological Results of the Third Tanganyika Expedition, conducted by Dr. W. A. Cunningham, 1904-1905.—Report on the Brachyurous Crustacea. By WILLIAM A. CUNNINGTON, B.A., Ph.D., F.Z.S.

[Received March 5, 1907.]

(Plates XVI. & XVII.\* and Text-figure 84.)

1. *Introduction.*

Since the year 1896, when Mr. J. E. S. Moore paid his first visit to Lake Tanganyika, our knowledge of the fauna of that lake, and of the interesting problems which are connected with it †, has considerably advanced. The single representative of the Brachyura then collected was described somewhat later ‡, but already, in 1887, a description had been given by Milne-Edwards § of another form brought from the lake by Captain Joubert. The description of this last-mentioned type was unfortunately very incomplete, while at that time no male specimen had been obtained. During Mr. Moore's second expedition, in 1899-1900, he succeeded in collecting further examples of both the species already known, and furnished male specimens of the form which Milne-Edwards had described from the female alone. Finally, a Third Tanganyika Expedition was dispatched in 1904, with the conduct of which I had the honour of being entrusted, and which has added yet again to our knowledge of the Brachyurous Crustacea of the lake.

The very earliest facts which were learned respecting the fauna of Tanganyika seemed to show that the animals it contained were not merely of an unusual type, but were different from those living in the other big African lakes. It is an interesting fact that, with the lapse of time and a very great increase in our knowledge of the lakes of Central Africa, this dissimilarity of Tanganyika has been not only confirmed, but rendered more and more striking. Among other animal groups, that of the Brachyura affords an excellent example of this remarkable state of things; so that a double purpose will be served by the description in this paper of Crabs from Nyasa, which lake has the normal characteristics of the African fresh-waters.

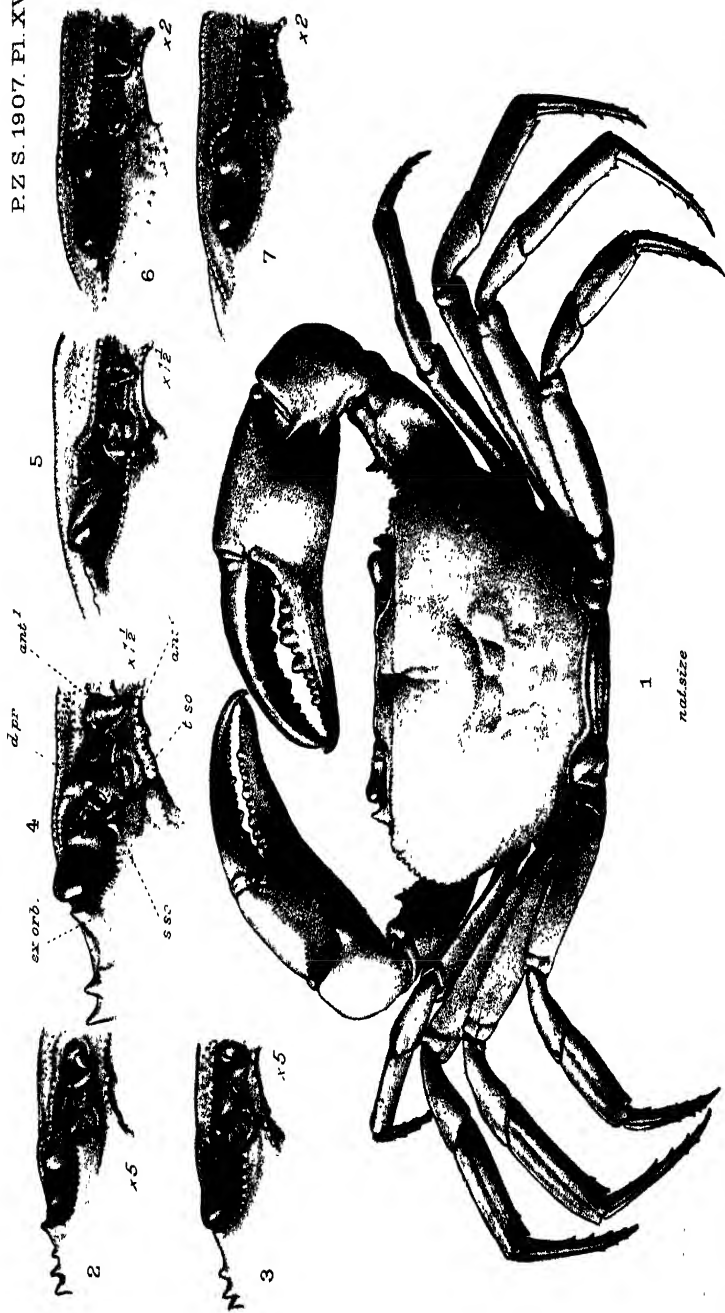
The collection of Crabs made during this Expedition contains representatives of five species, of which two alone have been previously described. By the kindness of Dr. W. T. Calman, I have been permitted to examine and compare with the collection a large number of specimens of nearly allied forms, belonging to

\* For explanation of the Plates, see p. 276.

† Moore, 'The Tanganyika Problem' (London, 1903).

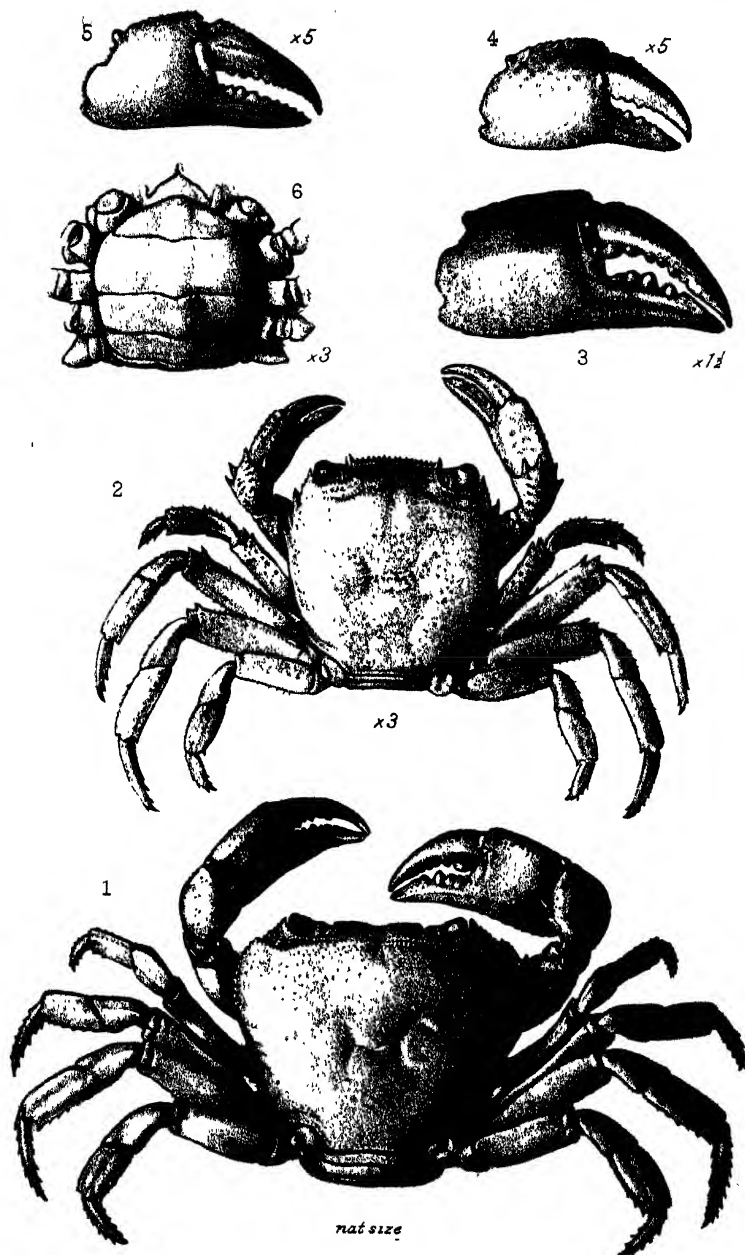
‡ Cunningham, Proc. Zool. Soc. 1899, p. 697.

§ Ann. Sci. Nat. 7<sup>e</sup> ser., Zool. t. iv. (1887) p. 146.



1. POTAMON (POTAMONAUTES) ORBITOSPINUS.  
2-7. ANTENNAL REGION OF VARIOUS POTAMONIDAE.





G.M. Woodward del. et lith.

West, Newman imp.

1 & 3, POTAMON (POTAMONAUTES) PLATYNOTUS.  
 2 & 4, PLATYTHELPUSA CONCULCATA.  
 5 & 6 PLATYTHELPUSA MACULATA.



the British Museum \*. Among others are some which are stated to have come from Nyasa and Tanganyika; and since no notice of these specimens appears to have been published, it seems desirable to consider them, also, in the present paper. The following is thus a complete list of the species at present known to occur in the lakes in question:—

#### NYASA.

- Potamon* (*Potamonantes*) *inflatus* (H. Milne-Edwards).  
 „ (*Potamonantes*) *orbitospinus*, sp. n.  
 „ (*Potamonantes*) sp. ?

#### TANGANYIKA.

- Potamon* (*Potamonantes*) *platynotus*, sp. n.  
 „ (*Potamonantes*) sp. ?  
*Platythelphusa armata* A. Milne-Edwards.  
 „ *maculata* (Cunnington).  
 „ *conculcata*, sp. n.

### 2. Systematic Notes and Description of New Species.

#### Family POTAMONIDÆ (= THELPHUSIDÆ).

##### Subfamily POTAMONINÆ.

##### *Lake Nyasa.*

#### POTAMON (POTAMONAUTES) INFLATUS (H. Milne-Edwards).

*Potamon* (*Potamonantes*) *inflatus* Rathbun, Nouv. Arch. Mus. Hist. Nat. Paris, 4<sup>e</sup> sér., vii. (1905) p. 174 (ubi synon.).

A single fair-sized male specimen in the collection of the British Museum (Reg. No. 96.7.19.1) appears to belong to this species. The only particulars given are:—"Kavisonda, Nyasa. Presented by Dr. Ansorge."

POTAMON (POTAMONAUTES) ORBITOSPINUS, sp. n. (Plate XVI. fig. 1.)

*Description.*—Carapace considerably flattened, antero-lateral margins arcuated and denticulate, extending laterally less than an orbit's breadth beyond the external orbital angle. No definite epibranchial tooth, but the end of the post-frontal crest forming a distinct corner at that point. Regions and sutures on carapace moderately marked, lateral regions exhibiting a series of small slightly oblique granular ridges. Front rather deflexed, less than one-third the width of the carapace, and with its anterior margin

\* By the courtesy of the authorities of the Berlin Museum, co-types of some of the species described by Hilgendorf from German East Africa were lent to the British Museum for the purpose of comparison with those discussed here. I am especially indebted to Dr. P. Pappenheim for detailed information regarding these specimens.

sinuated. Post-frontal crest prominent, almost straight, and extending to margins, with branches of mesogastric groove angulated. Orbits large, and eyes large, with stout peduncles. External orbital angle produced into prominent spine. Ischium of external maxillipeds showing longitudinal furrow, somewhat nearer to the inner edge. Chelipeds in both sexes subequal; merus trigonous, with a series of small spines and distally a prominent spine on the anterior margin; carpus with two spines on inner margin, the posterior being the smaller. Fingers pointed and slightly hooked; teeth fairly uniform, of moderate size. Ambulatory legs long and slender, also somewhat compressed. Colour in life dull dark green, shading into dark purple; the most prominent parts of the front, the external orbital spines, antero-lateral margins, and portions of post-frontal crest outlined in white; legs dark purple.

Dimensions as follows:—

Adult male (largest specimen):

	mm.
Length of carapace .....	38·4
Breadth of carapace .....	56·9
Fronto-orbital width .....	36·7
Width of front .....	13·8

Adult female:

Length of carapace .....	36·9
Breadth of carapace .....	53·9
Fronto-orbital width .....	34·5
Width of front .....	14·2

*Remarks.*—As there has recently been published a very comprehensive revision of the Potamonidæ by Miss Rathbun\*, it becomes desirable to take this as a basis, and correlate with it any newly described forms. Accordingly that portion of the key given by Miss Rathbun† which is affected is restated below, but slightly modified to include this new species, while distinguishing it from *johnstoni*, the species close to which it finds a place.

*h'*. Carapace broader; less than three-quarters as long as broad.

*j*. Antero-lateral margins denticulated; external orbital angle produced into prominent spine . . . . . *orbitospinus*.

*j'*. Antero-lateral margins granulated: external orbital angle forms low blunt process . . . . . *johnstoni*.

Even a casual study of the species comprised in the genus *Potamon* renders it abundantly evident that in many cases they cannot be distinguished by very striking differences of character. It is therefore the more important to make clear the actual points of disagreement which have been thought in this case to justify the formation of a new species. *P. orbitospinus* approaches most

\* Nouv. Arch. Mus. Hist. Nat. Paris, 4<sup>e</sup> sér., vi.-viii., 1904-1906.

† *Op. cit.* vii. p. 160.

nearly to the forms *P. hilgendorfi* (Pfeffer) and *P. johnstoni* (Miers). In order to render a comparison more easy, the diverging characters of these three species are given in tabular form, while it may here be stated that *P. orbitospinus* is a species certainly more easily recognised than some of those which are allied to it.

<i>hilgendorfi</i> (Pfeff.) (not <i>hilgendorfi</i> Hilg.).	<i>orbitospinus</i> , sp. n.	<i>johnstoni</i> (Miers).
Carapace somewhat flattened.	Carapace considerably flattened.	Carapace somewhat flattened.
Antero-lateral margins granulated.	Antero-lateral margins denticulated.	Antero-lateral margins granulated.
External orbital angle rather acute.	External orbital angle produced into prominent spine.	External orbital angle forms low blunt process.
Fronto-orbital width '71 that of carapace.	Fronto-orbital width '64 that of carapace.	Fronto-orbital width '59 that of carapace.
Ischium of external maxillipeds without longitudinal furrow.	Ischium of external maxillipeds with longitudinal furrow.	Ischium of external maxillipeds with longitudinal furrow.
Posterior carpal spine (of cheliped) little developed.	Posterior carpal spine (of cheliped) sharp and well developed.	Posterior carpal spine (of cheliped) little developed.
	Ambulatory legs long and slender.	Ambulatory legs short and stout.

*Occurrence.*—Nkata Bay, 23/6/04. Several specimens of medium size. The Crabs were captured and brought me by the natives, so that I have no direct evidence of their mode of life. They are said to live in the water and not on land, though they sometimes come on to the beach.

Three small and immature specimens in the collection of the British Museum (Reg. No. 91.12.19.1-3). Only the following particulars are given:—"Lake Nyasa, Coll. Miss M. Woodward, pres. by Miss Sophia McLaughlin."

One rather small male, no precise locality given, British Museum (Reg. No. 93.1.14.1). "Lake Nyasa. Received from Mr. Joseph A. Williams, Universities Mission, Likoma, Lake Nyasa."

One large female specimen, British Museum (Reg. No. 97.4.29.1). "West coast of Lake Nyasa from Ukala (? Nkata) Bay to Ruarwe, June 1896." "A. Whyte collector—pres. by Sir H. H. Johnston."

A single large male specimen, collected by Mr. J. E. S. Moore during one of his expeditions to Tanganyika, but without further particulars.



POTAMON (*POTAMONAUTES*) sp. ?

Reference has already been made to the fact that it is often difficult to distinguish between closely similar species of this genus. Many of the characters enumerated by the systematic writers on this group, while in certain cases affording a ready means of separating species, are in other cases of little or no value. A careful consideration of many of the described species and the examination of an extensive series of specimens lead to the undoubted conclusion that some species have been established without sufficient justification. While a species or even a genus may be established on the strength of a single specimen, if its characters are sufficiently unusual, it is necessary to be very cautious in doing anything of the kind within the limits of this subgenus (*Potamonautes*) in particular. Yet there are several species of *Potamonautes* based upon single specimens, and even upon specimens which were recognised as being immature. We do not know a great deal about the modifications in form produced by advancing age, but we do know, from the examination of any extensive series, that they are considerable. The proportion of length of carapace to its breadth, with the relative proportions of the front, the orbits, and the fronto-orbital width—all of them characters employed by the systematist—are undoubtedly dependent upon the age and growth of the individuals.

But more than this. A natural hesitation to lay stress on every little difference in form is only emphasized by the result of Schenkel's\* investigation of the species *Potamon* (*Potamonautes*) *celebensis* de Man. He is able to distinguish some six local varieties, in addition to the *forma typica* of de Man. These differ from one another in colour, in the shape of legs and carapace, in the extent of the sculpturing, and especially as regards the degree to which the carapace is vaulted and the branchial regions dilated. But, as Schenkel points out, these features are precisely those which would be affected by a difference of surroundings. He finds the Crabs with the flattest carapace come from mountain-streams, where of course the water is pure and well oxygenated. The converse holds equally good, the gill-chambers in other varieties being inflated in proportion to the sluggish or muddy nature of the river inhabited, and it is obvious that the sculpturing is in a great measure an expression of the degree of inflation of the carapace. Again, it is pointed out that the amount of the food-supply must have a powerful influence on growth: thus with two Crabs of similar size, that from water poor in nourishment will be far older than the other, and so not strictly comparable with it.

As Schenkel considered it desirable to retain a single species, but to constitute a number of varieties in this case, this discussion of the facts is very suggestive in a general sense. Under such circumstances, some observers would not even separate into

\* Verh. naturf. Ges. Basel, Bd. xiii. 1902, p. 528.

varieties, and, on the other hand, there can be no doubt that many so-called species of other writers are not more distinct than these varieties of Schenkel. If it is possible to trace a gradual transition from one variety to another, as appears to be the case with the form *celebensis*, it becomes evident that certain established species are of similarly little value, and that species of this genus ought never to be constituted on such slender grounds.

This matter is dealt with at such length, because the conviction has forced itself upon me that the number of African species, at all events, has been multiplied to an excessive degree. Where two or more well-marked species exist side by side, there can be no hesitation in the matter; but our knowledge of the Crabs of the African continent is still very scanty, and over a vast area restricted to a few isolated records. Thus it is impossible to determine yet whether this or that species may not prove to be only a slight local modification of some widely distributed form. This being the case, I have not ventured to name the two specimens from Nyasa, which are placed under the head-line above.

Although it was during my study of the two species described as new in this paper that I became impressed with the unsatisfactory character of some species of *Potamonantes*, it was not until I examined these two Nyasa specimens and a third from Tanganyika that I found a case where the most careful comparison only resulted in confusion with several closely allied species. The two specimens from Nyasa—a rather small male and a small female—are in the collection of the British Museum (Reg. No. 97.4.29.2-3), and the following note is given as to locality:—"Kondowe to Karonga, N. Nyasa, June 1896. A. Whyte collector—pres. by Sir H. H. Johnston."

Using as a basis the key in Miss Rathbun's recent revision, we find they belong to group c, where the lateral margins extend less than an orbit's breadth beyond the external orbital angle. Further, they would seem to belong to division e', where the post-frontal crest is little advanced in the middle, and to subdivision f', with fingers of the cheliped but slightly gaping. Thus they would come nearest to the species *hilgendorfi* (Peff.) and *johnstoni* (Miers). The specimens differ from *hilgendorfi* (Peff.) principally in possessing a furrow on the ischium. From *johnstoni* they differ in being distinctly longer in proportion to the breadth, in the sculpturing being less marked, and in the absence of the fairly stout spinules on the anterior margin of the carpus of the cheliped—a single distal spine only being present.

They agree to some extent also with *suprasulcatus pseudoperlatus*, which, if it exist at all as a true variety, is in a measure intermediate between *hilgendorfi* (Peff.) and *johnstoni*. The length in proportion to the breadth is, however, more extreme in the case of *suprasulcatus pseudoperlatus*. From another important type in group c—*perlatus* itself—these individuals do not differ greatly, the carapace being of much the same proportions as regards length and breadth. The width of the front is, however,

considerably less than in *perlatus*, and the post-frontal crest does not extend forward so far in the middle. The posterior carpal spine of the cheliped is also sharper and more prominent. Both the male and female specimens show only a single transverse furrow on the sternum in front of the abdomen, while in the specimens of allied species examined the males almost invariably have two furrows even in young individuals.

From this description of the characters of these two Nyasa Crabs, it will be evident that my former contention is not without foundation. These individuals agree to a considerable extent with several species, and where they disagree with one they agree with another, while, to my mind, they have not a single character which satisfactorily distinguishes them from those forms to which they are undoubtedly allied. In the present state of our knowledge, it would be futile to attempt to determine which species should be eliminated, and Miss Rathbun has certainly taken the right course in retaining most of the species hitherto described, though it seems to have led her into some difficulties respecting her key. Bearing in mind the facts which have been detailed at some length above, I prefer, in a case like this, to leave the specimens unnamed, and so at least avoid adding to the already existing superfluity.

*Lake Tanganyika.*

POTAMON (POTAMONAUTES) PLATYNOTUS, sp. n. (Plate XVII. figs. 1 & 3.)

*Description.*—Carapace much flattened, antero-lateral margins arcuated and denticulate, extending laterally slightly more than an orbit's breadth beyond the external orbital angle. No definite epibranchial tooth, but the end of the post-frontal crest forming a distinct corner at that point. Regions and sutures on carapace ill-defined, postero-laterally a few inconspicuous granular ridges. Front rather deflexed, less than one-third the width of the carapace, and with its anterior margin sinuated. Post-frontal crest prominent, slightly arcuated, but sinuated laterally, extending to margins; branches of mesogastric groove straight. Orbits, eyes, and peduncles small. External orbital angle existing as a short blunt spine. Ischium of external maxillipeds not showing longitudinal furrow, though this may be faintly indicated in the oldest specimens. Anterior portion of the sternum hairy in the female, not hairy in the male. Chelipeds in both sexes subequal; merus trigonous, with a series of granules, and distally a stout spine, on the anterior margin; carpus with a prominent spine on the inner margin and a slight process just behind it. Fingers distally hollowed out, spoon-shape and meeting closely in a sharp cutting-edge (Plate XVII. fig. 3); dactylus usually slightly longer than the pollex. Teeth fairly uniform, of moderate size, but the fingers of the larger chela gape a little and have proximally a few larger flat crushing-teeth. Ambulatory legs of moderate length, little compressed. Colour in life a uniform dull greenish brown; the dactyli of the chelipeds in the males usually black.

Dimensions as follows:—

Male (probably young specimen):	mm.
Length of carapace.....	20·3
Breadth of carapace .....	30·7
Fronto-orbital width .....	19·7
Width of front .....	10·1
Adult female (largest specimen):	
Length of carapace .....	33·7
Breadth of carapace .....	48·2
Fronto-orbital width .....	30·0
Width of front .....	13·8

*Remarks.*—This species comes into Miss Rathbun's key under the heading *c'*, where the carapace extends laterally more than an orbit's breadth beyond the external orbital angle. It finds its place in the same subdivision (*g'*) as the species *ambiguus* and *mrogoroensis*, and that portion of the key, modified to include it, is accordingly given below:—

- g'*. Anterior branch of cervical suture absent.  
*h*. Ischium of external maxillipeds without longitudinal furrow.  
*j*. Anterior portion of female sternum hairy . . . . . *platynotus*.  
*j'*. Anterior portion of female sternum not hairy . . . . . *mrogoroensis* \*.  
*h'*. Ischium of external maxillipeds with longitudinal furrow . . . . . *ambiguus*.

The principal points in which *platynotus* differs from *ambiguus* on the one hand and *suprasulcatus* on the other are also given in tabular form. The most striking features of the new species are

<i>suprasulcatus</i> Hilg.	<i>platynotus</i> , sp. n.	<i>ambiguus</i> Rathbun.
Carapace moderately vaulted.	Carapace much flattened.	Carapace distinctly vaulted
Antero-lateral margins granulated.	Antero-lateral margins denticulated.	Antero-lateral margins granulated.
Anterior branch of cervical suture present.	Anterior branch of cervical suture absent.	Anterior branch of cervical suture absent.
Fronto-orbital width '60 that of carapace.	Fronto-orbital width '82 that of carapace.	Fronto-orbital width '57 that of carapace.
Ischium of external maxillipeds without longitudinal furrow.	Ischium of external maxillipeds without longitudinal furrow.	Ischium of external maxillipeds with longitudinal furrow.
Fingers pointed and slightly hooked.	Fingers distally hollowed out spoon-shape.	Fingers pointed and slightly hooked.

the flattened carapace, the denticulated antero-lateral margin, and the character of the fingers.

\* It is by no means obvious why Miss Rathbun has inserted the form *mrogoroensis* here, under the heading *c'*, when it is quite clear from Hilgendorf's description,

*Occurrence*.—Kasakalawe and Kituta Bay, both south end of Tanganyika. Several specimens; some females probably full-grown, but the largest male apparently not so. The Crabs were taken under boulders about high-water level.

POTAMON (POTAMONAUTES) sp.

Under this heading, I place a single rather small male belonging to the British Museum (Reg. No. 89.2.8.1), of which the only particulars are: "Lake Tanganyika, E. C. Hore (ex coll.)." This specimen agrees with and differs from its near allies in very much the same way as the unnamed forms from Nyasa, which are dealt with above. Thus it finds its place near to the latter, with which it agrees in showing only a single transverse furrow on the sternum in front of the abdomen, although a male. It disagrees with the Nyasa form, however, in being less inflated and in showing the sculpturing more distinctly. Further, the anterolateral margins are more finely perlated, and the spine on the merus of the chelipeds is longer and sharper. In this case also the specimen differs little from several species, and appears to have no satisfactory distinguishing characters of its own, so that I again take the course least open to objection and leave it unnamed.

Genus PLATYTHELPHUSA A. Milne-Edwards.

*Platythelphusa* A. Milne-Edwards, Ann. Sci. Nat., Zool. 7<sup>e</sup> ser., t. iv. (1887) p. 146.

*Platythelphusa* Hilgendorf, Deutsch-Ost-Afrika, Bd. iv. Lief. ix. (1898) p. 21.

*Limnothelphusa* Cunningham, Proc. Zool. Soc. 1899, p. 698.

*Limnothelphusa* and *Platythelphusa* Moore, 'The Tanganyika Problem' (London, 1903), pp. 280, 286.

*Platythelphusa* and *Limnothelphusa* Rathbun, Nouv. Arch. Mus. Hist. Nat. Paris, 4<sup>e</sup> sér. vii. (1905) pp. 268, 269.

There are a number of reasons which have led me to offer here a new description of this genus established by A. Milne-Edwards in 1887. As I have stated elsewhere\*, the account given of the type species, *P. armata*, and particularly the figures of it, leave a good deal to be desired. Miss Rathbun reproduces a photograph of this same individual, and adds something to the description; but, as a result of the Second and Third Tanganyika Expeditions, we

very incomplete though it is, that his specimen should come into the group c, in which the carapace extends laterally less than an orbit's breadth beyond the external orbital angle. While it may perhaps be doubted whether the distinction given above under *j* and *j'* is of much weight, it will be evident that if the species *mrogoroensis* were withdrawn from its false position, the new form *platynotus* would then be distinguishable from *ambiguus* by the difference of the external maxillipeds. It is not necessary to discuss here the position which *mrogoroensis* should really occupy, the simpler course is taken of merely incorporating the new species in the existing key.

\* Proc. Zool. Soc. 1899, p. 701.

now possess in this country a fairly complete series of this species of both sexes. We have the possibility for the first time of comparing males with the female on which the genus was founded, and this might in itself justify a redescription. But a comparison between a large series of the form described as *Limnothelphusa maculata* and the specimens of *Platythelphusa armata* (which I was unable to make in 1899), has convinced me that the former cannot be regarded as constituting a separate genus, but falls into place as a species of *Platythelphusa*. A third species of *Platythelphusa* is among the acquisitions of the last expedition, so that the description which follows has been materially modified in view of our much more extensive knowledge.

*Description.*—Carapace almost quadrilateral; antero-lateral margins arcuated and armed with spines; postero-lateral margins but slightly arcuated. Front little deflexed, nearly straight. Post-frontal crest distinct and perlated, but not extending to lateral margins. Sub-orbital spine more or less distinct, in addition to prominent inner sub-ocular tooth. A stout triangular process descends from the external angle of the front, and may be produced into a small spine antero-distally. Antennæ situated partly behind and partly between this descending process of the front and the inner sub-ocular tooth; the distal segments thus escape an appearance of displacement by the front. Merus of external maxillipeds broader than long, the palp being attached to its antero-internal angle; ischium without longitudinal furrow. Ambulatory legs somewhat compressed, the fourth leg considerably shorter than the others, and with its two terminal segments broad and flattened.

*Remarks.*—With the inclusion of *Limnothelphusa*, this genus has lost nothing of its original distinctiveness. In the generic description of *Limnothelphusa*, stress was laid on the simple nature of the second antennal segment, which was undistorted by the deflexed front. Although it was perhaps not very happily expressed, this character is just as typical of the other two species we know from Tanganyika, and deserves emphasis accordingly. In those genera and subgenera where the front is considerably depressed, the antennæ have the appearance, at least, of a lateral displacement or distortion in consequence. All the species of *Platythelphusa* show the front little deflexed, but have a triangular process descending from the external angle, which process, however, passes to the front and side of the antenna, without modifying its shape or direction. In order to make this distinctive feature quite clear, the frontal region of all three species of *Platythelphusa* is figured, while corresponding figures are given of certain well-known species of the subgenera of *Potamon* (Plate XVI. figs. 2-7).

Owing to the modification of the generic characters of *Platythelphusa* and the suppression of the genus *Limnothelphusa*, Miss Rathbun's key to the subfamily Potamoninae\* requires

\* *Op. cit.* t. vi. p. 245.

alteration. In the restatement which follows, the subgenera are omitted, as they are not affected, and care has been taken to retain the original form as far as possible.

### Subfamily POTAMONINÆ.

- e. Ocular peduncles large, not tapering towards distal extremity.
- f. A stout triangular process descends from the external angle of the front PLATYTHELPHUSA.
- f'. No process descending from the external angle of the front.
- g. Front not armed with spines or spinules POTAMON.
- g'. Front armed with spinules HYDROTHELPHUSA.
- e'. Ocular peduncles small, tapering towards distal extremity. ERIMETOPUS.

Since there are now three species included in the genus *Platythelphusa*, it may be well to furnish a key to them, although they are much more distinct and well defined than is the case with many species of *Potamonautes*.

### Key to the Species of PLATYTHELPHUSA.

- a. Carapace extending laterally more than an orbit's breadth beyond the external orbital angle; front less than one-third width of carapace armata.
- a'. Carapace extending laterally less than an orbit's breadth beyond the external orbital angle; front more than one-third width of carapace.
- b. Carapace moderately convex; carpus of cheliped without spines on outer margin; ambulatory legs of moderate length, anterior margin of the merus without spines maculata.
- b'. Carapace extremely flattened; carpus of cheliped bearing spines on outer margin; ambulatory legs long, anterior margin of the merus produced distally into two spines conculcata.

PLATYTHELPHUSA ARMATA A. Milne-Edwards. (Text-figure 84.)

*Platythelphusa armata* A. Milne-Edwards, Ann. Sci. Nat., Zool. 7<sup>e</sup> sér., iv. (1887) p. 147.

*Platythelphusa armata* Hilgendorf, Deutsch-Ost-Afrika, Bd. iv. Lief. ix. (1898) p. 22.

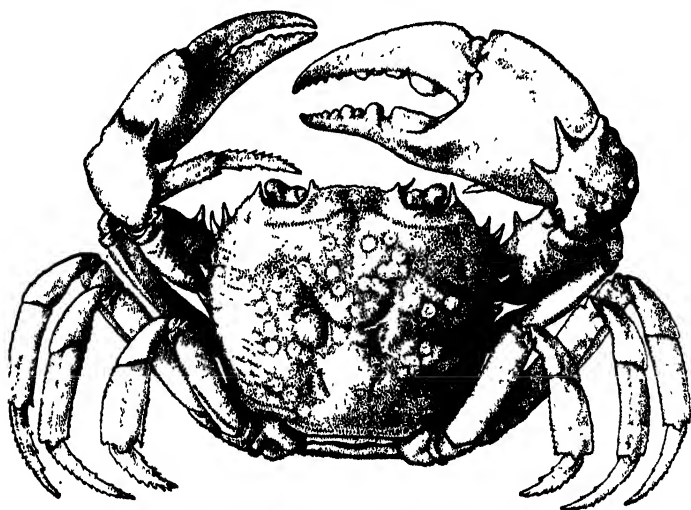
*Platythelphusa armata* Moore, 'The Tanganyika Problem' (London, 1903), p. 286.

*Platythelphusa armata* Rathbun, Nouv. Arch. Mus. Hist. Nat. Paris, 4<sup>e</sup> sér., vii. (1905) p. 269.

*Description*.—Carapace moderately convex, extending laterally more than an orbit's breadth beyond the external orbital angle. The antero-lateral margins differ little in length from the postero-lateral, with which they are almost directly continuous. Number of spines on antero-lateral margin extremely variable, usually four or five, in addition to the spine at the external orbital angle. Regions and sutures fairly well marked. The postero-lateral regions exhibit a series of small slightly oblique granular ridges.

Front less than one-third the width of the carapace, its margin perlated, and with a stout spine at each extremity. Sub-orbital spines short and stout; a small spine on the descending process of the front. Orbits small,  $\cdot 16$  width of carapace; orbital margins perlated. Eyes and peduncles small. Chelipeds in both sexes unequal; merus trigonous, with distally a prominent spine on the anterior margin, and a small spine or tubercle on the ventral margin; carpus with two spines on inner margin and one above the point of articulation with the hand. Hands and fingers somewhat compressed, the dorsal border being keeled and granulated; the ventral border in the larger chela characteristically arcuated at the junction of the pollex. Fingers pointed and slightly hooked; those of the larger chela gape, and have a pair of large flat crushing-teeth proximally, with a series of rather smaller ones distally. In the smaller chela the teeth are fairly uniform and of moderate size. Ambulatory legs of moderate length. Colour, in life, yellowish brown, with irregular blotches of darker brown on the carapace.

Text-fig. 84.

*Platythelphusa armata*, large male.  $\times \frac{1}{3}$ .

Milne-Edwards and Miss Rathbun give the detailed dimensions of an adult female (type specimen), but as we now possess for the first time particulars of males, the measurements of an adult male—the largest known specimen—are included here. In this individual (text-fig. 84) the size of the larger chela is very striking, the length of the hand and pollex being greater than the whole breadth of the carapace.



Adult male (largest specimen), Moore's collection :	mm.
Length of carapace.....	53·2
Breadth of carapace .....	66·3
Fronto-orbital width .....	40·1
Width of front .....	18·7
Larger chela : greatest length of hand and pollex.	71·3
„ „ greatest height of hand .....	35·8

*Remarks.*—While the chelipeds in both sexes are unequal, it appears that either the right or left may be the larger, quite indiscriminately. The large crushing-teeth are often considerably worn in old specimens, and the spines of carapace and chelipeds become blunt and rounded. This is, in fact, the case with the male specimen which is figured, where it is clear that certain of the spines have lost their original sharpness, but it should be understood that the spines in question are normally very sharp and strong.

A curious feature of the specimens of this Crab is the number of circular blotches which appear on the surface of the carapace and appendages. The marks are approximately round, and seem due to an eating-away of the calcareous matter of these spots, which occur in greater numbers on larger and older specimens. In some cases the fingers of the chelæ have suffered severely, being partially eaten through by this process of erosion. It seems most probable that these blotches are due to the action of boring Algæ. A portion of test including such a spot was decalcified, cleared, and mounted in balsam, but showed little structure even then. From a central point, a number of fine processes, or perhaps tubules, could be seen to radiate, but nothing further could be made out.

*Occurrence.*—The locality is given by Milne-Edwards simply as Lake Tanganyika. Moore states\* that he obtained this species only off the west coast of the lake, and in nets and dredges worked in water of about 20 fathoms. The experience of the third Expedition shows that it occurs more widely distributed in the lake, and may be taken in much shallower water than 20 fathoms.

Kasakalawe (south end): a single, rather young specimen, taken under a stone about water-level, at the same time as specimens of *Potamon* (*Potamonautes*) *platynotus*.

Mbete (south end): two or three young specimens came on board my dhow clinging to the anchor-chain. The vessel was probably anchored in two or three fathoms of water.

Among a number of specimens of *Platythelphusa maculata*, dredged in 10–15 fathoms, principally at the south end of the lake, are two or three small Crabs belonging to this species.

Vua, on the west coast: a single adult, seen from the dhow crawling about in a foot or two of water, and caught in a hand-net.

North end of the lake: a single specimen not full-grown.

\* *Op. cit.* p. 280.

*PLATYTHELPHUSA MACULATA* (Cunnington). (Plate XVII. figs. 5 & 6.)

*Limnothelphusa maculata* Cunnington, Proc. Zool. Soc. 1899, p. 698.

*Limnothelphusa maculata* Moore, 'The Tanganyika Problem' (London, 1903), p. 280.

*Limnothelphusa maculata* Rathbun, Nouv. Arch. Mus. Hist. Nat. Paris, 4<sup>e</sup> sér., vii. (1905) p. 269.

As this species is now regarded as falling under the genus *Platythelphusa*, in consequence of the examination of much more extensive material, it becomes evident that it merits a more complete specific description, which accordingly follows.

*Description*.—Carapace moderately convex, extending laterally less than an orbit's breadth beyond the external orbital angle. Antero-lateral margins shorter than postero-lateral, with which they are almost directly continuous. Number of spines on antero-lateral margin variable, usually three, in addition to the spine at the external orbital angle. Regions and sutures moderately marked. Postero-lateral regions exhibit a series of small slightly oblique granular ridges. Front more than one-third the width of the carapace, margin perlated, and in extreme cases produced into a small spine at each extremity. Sub-orbital spines little developed: no spine on the descending process of the front. Orbits large, .24 width of carapace; orbital margins perlated. Eyes and peduncles large. Chelipeds in the male unequal, subequal in the female; merus rather short, trigonous, with distally a sharp spine on the anterior margin; carpus with two spines on inner margin and one above the point of articulation with the hand. Fingers of the larger chela gape considerably, are pointed and slightly hooked, and carry a few larger crushing-teeth proximally, with smaller teeth distally. Fingers of the small chela, and both chelæ of the female (Plate XVII. fig. 5), distally meet closely in a sharp cutting-edge, while proximally there are uniform teeth of moderate size. Ambulatory legs of moderate length. Colour in life dark brownish grey, with dark brown or reddish spots.

As now there has been obtained quite an extensive series of specimens, some of which are larger than those examined before, it seems worth while to furnish a further list of dimensions, to compare with those given under the original description of this species. As in the case of *P. armata*, the larger chela of old male specimens is of a great size, the length of hand and pollex exceeding the total breadth of the carapace.

Adult male :	mm.
Length of carapace .....	12.9
Breadth of carapace .....	16.4
Fronto-orbital width .....	13.2
Width of front .....	6.1
Larger chela : greatest length of hand and pollex	16.9
"      "      greatest height of hand .....	8.7

Adult female (largest specimen) :		mm.
Length of carapace .....		13.1
Breadth of carapace .....		16.9
Fronto-orbital width .....		13.2
Width of front .....		6.1

*Remarks.*—While none of the specimens examined in 1899 carried ova, it is satisfactory, on comparison with this more extensive collection, to find that those regarded as adult were so in reality. Female specimens of approximately the same size as that described, but one of which is ovigerous, while the other carries the already liberated young, occur in the recent collection. Indeed we have further a female with total breadth of only 12.4 mm., but which is nevertheless ovigerous. The average size of the eggs themselves, which are not quite round, is  $1.9 \times 1.5$  mm.

The much smaller size of this species enables it to be distinguished at once from adult specimens of *P. armata*, but, apart from that, the great relative breadth of the front and size of the orbits are differences easily recognised. Among the number of specimens which we now possess there exists considerable individual variation in respect to the development of certain spines, and this accounts for a slight discrepancy which may be noticed between the foregoing description and that given in the first instance. In the original type specimens, the spine on the carpus of the cheliped, above the articulation with the hand, is indicated but slightly, if at all. As it is, however, very well developed in a number of individuals, it is now included among the specific characters. Again, certain of the new specimens exhibit a small spine at each extremity of the front, and have a slight indication of sub-orbital spines, while others show no trace of these features. A more complete description of the fingers of the chelipeds is now given, and from my own observations I can add the coloration during life.

*Occurrence.*—The type specimens described in 1899 were obtained, according to the information supplied me by Mr. Moore, from Kituta Bay (south end), while he had also taken specimens at Niamkolo (south end) and Sumbu on the west coast. The Crabs were said to have been captured in fairly deep water—never less than 60, and from that to 500 feet deep. In his book on Tanganyika, however, Moore states\* that the specimens were obtained in water varying in depth from 500 to 600 feet. He also adds that the Crab occurs throughout the lake. With the latter statement, the experience of the recent Expedition is quite in accord; but whether the original individuals came from such very deep water or not, it is certainly a fact that the species may be found in much shallower regions.

Niamkolo Bay (south end): a large number of specimens

\* *Op. cit.* p. 280.

dredged among shells in about 10–15 fathoms. Also obtained in rather shallower water, but seldom in less than about 8 fathoms.

Pembe (east coast): among shells dredged in about 10 fathoms.

Kirando (east coast), 1/12/04: dredged in about 10 fathoms. Among these, a curiously blotched and not spotted individual.

*PLATYTHELPHUSA CONCULCATA*, sp. n. (Plate XVII. figs. 2 & 4.)

*Description*.—Carapace extremely flattened, extending laterally less than an orbit's breadth beyond the external orbital angle. The whole body remarkably thin in appearance. Antero-lateral margins shorter than postero-lateral, with which they are almost directly continuous. Three spines on antero-lateral margin, in addition to that at the external orbital angle. Regions and sutures very ill-defined. Lateral regions exhibit a few small granular ridges. Front more than one-third the width of the carapace, margin spinuliferous and with a sharp spine at each extremity. Sub-orbital spines prominent; a small spine on the descending process of the front. Orbits of moderate size, '18 width of carapace; orbital margins perlated. Eyes and peduncles rather large. Chelipeds in the male subequal; merus trigonous, with distally a sharp spine on the anterior margin, and a small blunt spine on the ventral margin; carpus with two spines on inner margin, two on outer margin, and one above the point of articulation with the hand. Fingers distally meet closely in a sharp cutting-edge, while proximally there are uniform teeth of moderate size. Fingers of the larger chela (Plate XVII. fig. 4) have a few larger teeth proximally. Ambulatory legs long and slender; the anterior margin of the merus, in each case, produced distally into two sharp spines, of which the terminal one is inconspicuous on the first and fourth legs. Colour (in spirit) yellowish brown, with darker reddish-brown spots.

Dimensions as follows:—

Male (probably adult):	mm.
Length of carapace .....	10·0
Breadth of carapace .....	11·9
Fronto-orbital width .....	9·1
Width of front .....	5·0

*Remarks*.—It is unfortunate that we possess only a single specimen of this species, which appears nevertheless to be quite well marked. In size it is still smaller than *P. maculata*, while the much flattened carapace and remarkable thinness of the body (whence the name) at once arrest the attention. The great development of spines is also striking, there being two additional ones on the outer margin of the carpus of the cheliped and the same number on the anterior margin of the merus of the ambulatory legs.

*Occurrence*.—The only specimen obtained was associated with

*P. maculata*, and dredged among shells in 10–15 fathoms of water at the south end of the lake.

### 3. General Remarks.

The principal result of our extended knowledge of the Brachyura of the African lakes is to make still more clear the very special nature of the Crab-fauna of Tanganyika. As is found to be the case in so many different groups of animals, the forms occurring in Tanganyika are for the most part endemic, while those found in the other big lakes are often of wide distribution. There occur in Nyasa, as we have seen, three species of *Potamonautes*, one of which, it is true, is described from that lake only. In the Victoria Nyanza, we find *Potamon* (*Parathelphusa*) *niloticus*, a very widely distributed form, and *P. (Geothelphusa) emini*, also known from Abyssinia. From the Albert Edward Nyanza there comes also a species of *Geothelphusa*. Thus, with the single exception of *P. (Potamonautes) orbitospinus*, from Nyasa, the forms at present known from these big lakes are by no means confined to them.

With Tanganyika it is quite otherwise. There are two species of *Potamonautes*, one of which is not known elsewhere, but beyond this, three species of a unique and remarkable genus wholly restricted to this lake. From the other lakes we have then only representatives of the subgenera of *Potamon*—forms such as are widely distributed in the tropical fresh-waters of the Old World. From Tanganyika, while we have some representatives of these normal African types, we have a preponderance of forms perfectly distinct and occurring nowhere else. There is an indication, too, of that richness of the Tanganyika fauna which is so noticeable in some other animal groups. We know of five species of Crabs from Tanganyika, three from Nyasa, and only two from the Victoria Nyanza.

It is necessary to add a few remarks on the affinities of the genus *Platythelphusa*. The species *P. armata* has been considered to exhibit a distinctly marine appearance. Milne-Edwards stated in the course of his original description that the Crab bore such a resemblance to certain marine or brackish-water Grapsidæ that we might relate it to that group, were it not for the development of the abdomen and the absence of metamorphosis. In his book on 'The Tanganyika Problem,' Moore\* very rightly challenges the value of such a character as the latter to the systematist. If the absence of metamorphosis is the result of a particular habitat, as we have reason to suppose, we ought not to take it into account when we attempt to determine the affinities of a newly-discovered specimen. At the same time it would seem as if the resemblance to the Grapsidæ could be only a very superficial one, produced, perhaps, by the more or less quadrilateral shape of the carapace.

\* *Op. cit.* p. 238.

It must be admitted that the considerable development of spines, which we find in all these species, is a feature more commonly found among marine Crabs than among those inhabiting fresh-water, and so would in itself convey a false impression on a casual inspection. But we need not go outside the subfamily of the Potamoninae to find examples of Crabs which are just as "marine looking," as far as the development of spines is concerned. This is true of a number of species of *Parathelphusa*, and when we pass to the other subfamilies of the Potamonidae, we have *Potamocarcinus*, *Valdivia*, and *Dilocarcinus*, all extremely well armed with spines. As with all these genera and subgenera, there can be no doubt that *Platythelphusa*, despite its appearance, finds its nearest allies in this group of forms which are essentially and typically fresh-water in habitat.

It is a matter of more difficulty to decide which of the allied forms are most closely related to *Platythelphusa*. The species now known as *P. maculata* has been stated to be a primitive form\*, on account of the little deflection of the front, the nature of the antennae, and the spine-bearing margins of the carapace. These features are equally characteristic of the other two species of the genus, and do seem to show less specialisation than the deflexed front and inflated gill-chambers of some of the semi-terrestrial species of the subgenus *Potamon*. It is then not with the latter, but near the genus *Hydrothelphusa* and the subgenus *Parathelphusa* that we ought probably to place this distinctive Tanganyikan genus.

The problem of the origin of Lake Tanganyika, about which so much has been said and written, is of course intimately connected with the questions which have just been discussed. If the lake be the modified remains of part of an ancient ocean, we may expect its inhabitants to show both a primitive character and a marine aspect. These, Mr. Moore considers, are exhibited by all the members of his "halolimnic" group, among which are reckoned the species of *Platythelphusa*. It has been shown, however, that this genus has no better claims to a marine origin than other representatives of the family, and at the same time, that while it is not so specialised as certain allied forms which have adopted a partially terrestrial mode of life, neither need it be considered as the most primitive in the group. Still there is little evidence that this form was ever anything but wholly aquatic, and it may have become modified by the truly oceanic conditions prevailing in Tanganyika, until it attained a superficial resemblance to marine types.

In his report on the Macrurous Crustacea of the Expedition, Dr. Calman shows† that they are to be regarded rather as specialised than as primitive in character, and it may be asked

\* Proc. Zool. Soc. 1899, p. 702.

† Proc. Zool. Soc. 1906, p. 204.

why the same is not true of the Brachyura. An explanation is really not far to seek. All the Macrura concerned are wholly aquatic types, while among the Brachyura we have to institute comparisons with forms which have partially accustomed themselves to a terrestrial existence. Such a profound change in habits must produce an effect which, in comparison, would dwarf any modification brought about within the limits of a single medium.

There is gradually being accumulated a mass of information concerning the other animal groups inhabiting Tanganyika, and in nearly every case it is found that the forms are to a large extent endemic and, moreover, very distinct and highly modified. The explanation of this fact will be equally the explanation of the remarkable character and variety of the Tanganyika Crab-fauna, when compared with that of the other great African lakes. There seems little doubt that it is to be found in a growing divergence taking place in the lake during a prolonged period of isolation.

#### EXPLANATION OF THE PLATES.

##### PLATE XVI.

- Fig. 1. *Potamon (Potamonautes) orbitospinus* (p. 259). Adult male, general view from above. Nat. size.  
 Figs. 2-7. Series of figures of *Platythelphusa* and *Potamon* to show the frontal region and illustrate the relations between the front, descending process, and antenna (p. 267).  
 Fig. 2. *Platythelphusa maculata*.  $\times 5$ .  
 3. *Platythelphusa conculcata*.  $\times 5$ .  
 4. *Platythelphusa armata*.  $\times 1\frac{1}{2}$ .  
 5. *Potamon (Parathelphusa) niloticus*.  $\times 1\frac{1}{2}$ .  
 6. *Potamon (Potamonautes) platynotus*.  $\times 2$ .  
 7. *Potamon (Potamonautes) perlatus*.  $\times 2$ .

##### PLATE XVII.

- Fig. 1. *Potamon (Potamonautes) platynotus* (p. 264). Adult female, general view from above. Nat. size.  
 2. *Platythelphusa conculcata* (p. 273). Male, general view from above.  $\times 3$ .  
 3. *Potamon (Potamonautes) platynotus* (p. 264). Larger chela of adult female, to show nature of dentation.  $\times 1\frac{1}{2}$ .  
 4. *Platythelphusa conculcata* (p. 273). Larger chela of male, to show nature of dentation.  $\times 5$ .  
 5. *Platythelphusa maculata* (p. 271). Chela of female, to show nature of dentation.  $\times 5$ .  
 6. *Platythelphusa maculata* (p. 271). Abdominal region of a female, from below, to show the large size of the abdomen, and the degree to which it covers the sternum.  $\times 3$ .

##### Reference Letters.

ant. 1. Antennule.  
 ant. 2. Antenna (second segment).  
 d.pr. Descending process of front.

ex.orb. External orbital spine.  
 s.so. Sub-orbital spine.  
 t.so. Sub-ocular tooth.

5. On Two new Species of the African Genus *Microchætus* belonging to the Collection of Oligochæta in the Museum of Christiania. By FRANK E. BEDDARD, M.A., F.R.S., Prosector to the Society.

[Received February 1, 1907.]

(Text-figures 85 & 86.)

Dr. Robert Collett, the well-known chief official of the Christiania Museum, was so good as to entrust me, some little time since, with the collection of Oligochæta belonging to that Museum for study and description. In examining the collection I found three specimens, representing two species, of the Ethiopian genus *Microchætus*\* which I believe to be new to science, and of which I beg to lay the following descriptions before the Society.

*MICROCHÆTUS COLLETTI*, sp. n.

I have the pleasure of dedicating this obviously new species to Dr. Collett. The material consists of but one specimen, which is entire, but considerably softened. It measures about 170 mm. in length by 7 mm. in breadth after the clitellum; the anterior region of the body is wider. The colour is grey-brown, yellow on the clitellum.

The *setæ* have the usual paired arrangement found in this genus, and commence upon the second segment of the body. The *setæ* are smaller upon the anterior segments and considerably larger in the clitellar region, where they are quite twice the length. The larger *setæ* are ornamented. Some of the anterior segments consist of two rings.

The *clitellum* (text-fig. 85) is very sharply marked off by its colour and by the greater thickness of the body-wall in this region. It commences with the xivth and ends with the xxivth segment. The position of the clitellum is not anomalous for the genus, and the specimen permits of no doubt upon the matter. The clitellum is perhaps best described as "saddle-shaped"; but, as a matter of fact, the clitellar epithelium has also invaded the ventral surface. There is, however, a diminution in thickness indicated by an overhanging of the body-wall just ventralwards of the lateral *setæ*. This arrangement is interfered with in the region of the genital papillæ by those structures, as will be seen by the accompanying figure (text-fig. 85).

The *nephridiopores* are obvious and in front of the lateral pair of *setæ*.

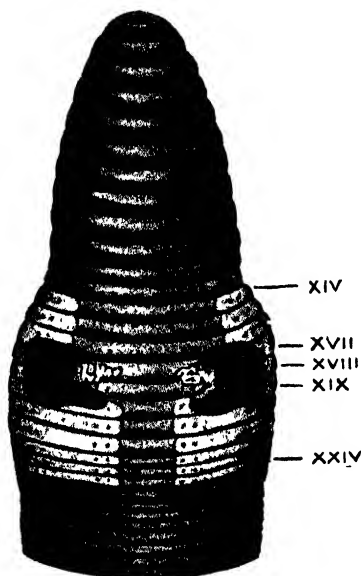
The *oviducal pores* are very conspicuous upon the xivth segment. Each lies between and in the same line with the ventral and dorsal *setæ*.

\* In addition to the species known up to the end of last century (see Michaelsen, Oligochæta in 'Das Thierreich'), *M. griseus* has been subsequently described (see Michaelsen, MT. Mus. Hamburg, xix. 1904).



The *genital papillæ* (see text-fig. 85) are large and conspicuous; they occupy the xviith, xviiiith, and xixth segments. They are quadrangular in shape, with rounded angles, and each is continued by a narrow ridge towards the middle ventral line. I traced the sperm-ducts in the interior of the body as far as the segments occupied by the genital papillæ, in connection with which I presume that they open. But I am unable to fix more precisely the point of opening.

Text-fig. 85.

*Microchætus colletti.*

I have not found it altogether easy, in view of the condition of the specimen and my unwillingness to injure it, as it is a type, to ascertain the position of certain of the internal organs. Assuming that the single pair of sperm-sacs is in the xth segment, the strongly marked *gizzard* lies in segment vii. This segment is followed by two very *thick septa*, which thus separate segments vii./viii. and viii./ix. The *dorsal vessel* is double in parts, and in segment ix. each half is much dilated, and a heart-like structure is formed precisely like that which I first described in *Microchætus microchætus*\*, and which also occurs in other species. The last pair of lateral contractile hearts lies in segment xi. The *calciferous glands* are in segment ix.

The *spermatheca*, which are, as is the case with other species of this genus, minute in size, open on to the boundary-line of

\* Trans. Zool. Soc. xii. p. 63.

segments xi./xii. and xii./xiii. There are either three or four on each side of the nerve-cord in each segment scattered between the ventral region of the segment and the dorsal mid-line.

*Copulatory glands* are rather numerous in this species. There are three pairs anteriorly, which lie respectively in segments x., xi., and xii. Each gland is double, as is commonly the case, being composed of two sausage-shaped glands uniting to form a common duct. They lie to the inside of the sperm-duct, which is almost or quite in contact with them as it passes back to the external pore. In addition to these three smaller pairs of glands there is a single much larger pair lying two or three segments behind the clitellum, and occupying a similar position in the body. Each of these glands is also double; but each tubular half is longer and is coiled once upon itself. There are no conspicuous bundles of genital setæ associated with any of these copulatory glands.

The locality of the species is "Zululand."

*MICROCHAETUS ZULUENSIS*, sp. n.

Two fragments contained in the same tube and from the same locality as the species just described clearly belong to the same genus, but as plainly constitute another species of that genus hitherto undescribed. Both fragments include the entire head and body for a long way behind the clitellum. I do not give exact measurements; the diameter of the anterior part of the body is 12 mm. or so. The worms thus belong to a larger species than *Microchaetus colletti*.

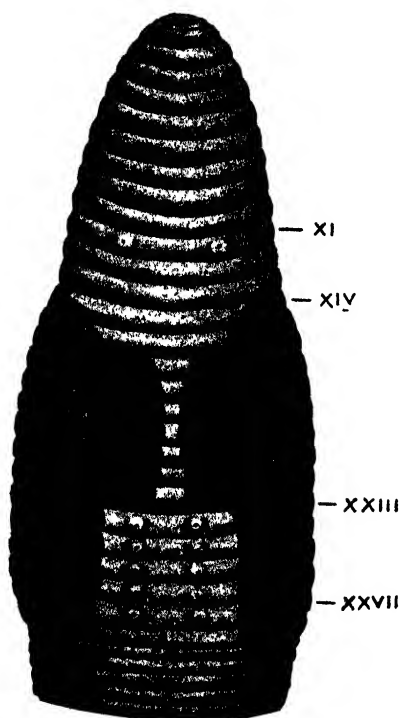
One of the specimens (text-fig. 86) is more fully mature than the other, and there is a difference in the number of the genital papillæ which is not attributable to immaturity. I am thus able to give a better account of external characters. But as the worms are much softened my examination of the internal anatomy has led to less satisfactory results. Nevertheless, I have been able to make out certain anatomical facts which are of importance in the discrimination of species.

The setæ are so minute and difficult to see upon many segments that I have found it impossible to map the regions of the body by their aid only. Assuming, however, that the male pores are upon the border-line of segments xiv./xv., a very usual position for them to occupy in this genus, and that the gizzard is in segment vii., which is also the case with other species, I arrive at the following determination of the position of the clitellum and of other organs.

In the fully mature individual the *clitellum*, recognisable on the xivth segment, is completely developed on the xvth, and extends to the end of the xxviiiith. It is saddle-shaped, a bare ventral area being left. In addition to the clitellum, segments xvi.-xxii. possess on either side a longitudinal band distinct from the clitellum, though of the same appearance in general, coupled with slight dissimilarity in colour, which is plainly the *tubercula*

*pubertatis*. This is confirmed by the fact that in the second immature example without a clitellum the tubercula pubertatis were nevertheless quite plain, though apparently occupying a segment less.

Text-fig. 86.

*Microchaetus zuluensis*.

The *copulatory papillæ* (text-fig. 86) with their setæ are very obvious and very numerous in this species. In both specimens there are two series of these papillæ, one anterior to the clitellum and one on some of the posterior segments of the clitellum. In the fully mature individual with the completely developed clitellum there is a single pair of these structures on segment xi., a papilla of the pair being situated a little to the dorsal side of each ventral pair of setæ. These (the ventral) setæ are also present on the xith segment. These anterior papillæ are considerably larger than those of the posterior series. The latter are in all five pairs situated on segments xxiii.-xxvii. inclusive, thus immediately continuing on the tubercula pubertatis. In the immature individual there were the same papillæ upon the xith segment; but in

addition to these there was a smaller pair upon the xiiith segment, more ventrally placed, and in fact corresponding in position to the posterior series. These latter papillæ in the present specimen are fewer than in the adult, but they commence upon the same segment, i. e. the xxiiird. There are four upon the right side of the body and only two upon the left.

The *gizzard* is distinctly contained in two segments, which are the viith and viiith; the greater part of it, however, lies in segment vii. The *mesenteries* separating segments vi./ix. are thick. The rather small *calciferous glands* are in segment ix.; the intestine begins suddenly in segment xi. The *dorsal blood-vessel* is dilated in segment ix. I imagine that this species is one of those which only possess one set of testes, funnels, &c. For the *sperm-sacs and reservoirs* consist of one pair in the ixth segment attached to the posterior wall of that segment and a pair in the xth attached to its anterior wall, i. e. the same septum as that which bears the sperm-sacs. The two sacs of each side of the body seem to communicate, and I take the anterior pair to be the sperm-sacs and the posterior pair to contain the funnels.

I was quite unable to find any spermathecae. I am unwilling, however, to assert that these organs are absent. If they happened to contain no sperm their minute size and the softened condition of the worm would render it at least very difficult to detect them. The only other species, as it appears, in which no spermathecae have been detected is Dr. Michaelsen's recently described *M. griseus*\*. But as this latter species is holandrous it cannot be confused with *M. zuluensis*, than which it is also a good deal smaller.

March 19, 1907.

Dr. HENRY WOODWARD, F.R.S., Vice-President, in the Chair.

The Secretary read the following report on the additions that had been made to the Society's Menagerie in February 1907 :—

The registered additions to the Society's Menagerie during the month of February were 76 in number. Of these 27 were acquired by presentation and 10 by purchase, 36 were received on deposit, 1 by exchange, and 2 were born in the Gardens. The total number of departures during the same period, by death and removals, was 188.

Among the additions special attention may be directed to :—

A Long-tailed Goral (*Nemorhædus caudatus*), from Korea, new to the Collection, presented by Mr. C. F. G. Bilbrough on Feb. 5th.

A Harpy Eagle (*Thrasaëtus harpyia*) from South America, purchased on Feb. 8th.

Mr. Herbert F. Standing read a paper, illustrated by lantern-

\* *Loc. cit.* (on p. 277).

slides and large series of photographs and specimens, on recently discovered subfossil Prosimiæ from Madagascar, in which he discussed their affinities with extant Lemurs and with the higher Primates. The remains were obtained in the muddy bed of a swamp formed by the blocking-up of the river Mazy by a lava-flow, at from a few inches to 3 or 4 feet below the surface. They consisted of a large number of skulls and limb-bones of Lemurs and Lemur-like animals. This great amount of material enabled the author to corroborate the view, previously put forward by Dr. Forsyth Major, that the extinct Lemurs of Madagascar were, in many respects, intermediate between existing Lemurs and Monkeys, and to express his belief that the New World Monkeys and the Lemuridæ, as well as the Malagasy Indrisinæ, had a common origin. He also stated his opinion that, in view of the recent additions to our knowledge of the Prosimiæ and of what the present collection revealed with regard to their close relationship to the Apes, it was not possible to separate the Primates, as hitherto, into the two suborders Lemuroidea and Anthroproidea.

This paper will be printed entire in the 'Transactions.'

The following papers were read:—

# 1. Descriptions of some New Species of Animal Parasites.

By L. W. SAMBON, M.D., F.Z.S.\*

[Received March 19, 1907.]

## WELLCOMIA MITCHELLI Sambon.

Abstr. P. Z. S. 1907, p. 15 (March 26).

*Habitat.* Small intestine of *Pedetes cafer*.

Only females found, 12–15 mm. long and about 1 mm. broad, characterised by the presence of a conical ovipositor 2–3 mm. long, placed ventrally on the anterior third of the body, 2–3·5 mm. from the cephalic extremity, and by a spirally twisted tail, 2–3 mm. long, terminating in a fine point. Body semitransparent. Head tapering anteriorly. Mouth trilabiate; œsophagus long and terminating in a spherical bulb. Anus open ventrally at 3–4 mm. from tail-end. Eggs smooth, oblong, asymmetrical, and measuring 60–65  $\mu$  by 28–32  $\mu$ .

## SPARGANUM BAXTERI Sambon.

Abstr. P. Z. S. 1907, p. 16 (March 26).

*Habitat.* Connective tissue of Man.

Long, flat, unsegmented body, 15 cm. long and 1·5 mm. broad,

\* [The complete account of the new species described in this communication appears here; but since the names and preliminary diagnoses were published in the 'Abstract,' the species are distinguished by the name being underlined.—EDITOR.]

with numerous irregular transverse folds and a distinct longitudinal groove on ventral surface. Anterior extremity 2-5 mm. broad; head completely invaginated. Posterior extremity 2 mm. broad, with shallow median slit. Extracted from an abscess on the thigh of a Masai in British Central Africa.

SCHISTOSOMUM MANSONI Sambon.

Abstr. P. Z. S. 1907, p. 16 (March 26).

*Habitat.* Blood-vessels of Man.

In the Congo Free State, in other parts of Africa, and in the West Indies there is a form of Bilharziasis clinically and pathologically similar to the Asiatic form caused by *Schistosomum japonicum*, and unlike the classic East African form due to *S. hæmatobium*. The eggs of the species which causes this peculiar form are never found in the urine, but seem to be eliminated through the intestine only. They differ from those of *S. hæmatobium* in having a broad lateral spine totally different in size, shape, and position from the small, straight, terminal spine which characterises the ova of *S. hæmatobium*. Hitherto, the laterally spined ova, usually observed in Egypt in cases of mixed infection, have been looked upon as having been distorted while passing through the rectal mucosa. Sir Patrick Manson suggested several years ago, that the laterally spined ova found in the fæces of patients, and never in the urine, might represent a new species. In appreciation of this, one of his many genial intuitions, the new species is dedicated to him.

2. Descriptions of five New Species of Hæmogregarines from Snakes. By L. W. SAMBON, M.D., F.Z.S., and C. G. SELIGMANN, M.D., F.Z.S.\*

[Received March 19, 1907.]

HÆMOGREGARINA POCOCCI Sambon.

Abstr. P. Z. S. 1907, p. 16 (March 26).

*Habitat.* Erythrocytes of Indian Python, *Python molurus* L.

Club-shaped, 14-16  $\mu$  long. Anterior extremity rounded, 3-15  $\mu$  broad. Posterior extremity attenuated and recurved. Cytoplasm more or less granular. Nucleus median or nearer posterior extremity, large, oval, and with coarse, deeply staining chromatin granules. Parasite lies parallel or obliquely to long axis of host-cell, of which it occupies about two-thirds, without causing much alteration beyond displacement of nucleus.

\* [The complete account of the new species described in this communication appears here; but since the names and preliminary diagnoses were published in the 'Abstract,' the species are distinguished by the name being underlined.—EDITOR.]

HÆMOGREGARINA SHATTOCKI Sambon.

Abstr. P. Z. S. 1907, p. 17 (March 26).

*Habitat.* Erythrocytes of Diamond Snake, *Python spilotes* (Lacép.).

Club-shaped. Some forms more slender, 14-15  $\mu$  long and 2  $\mu$  broad, with both extremities rounded and differing only slightly in thickness. Other forms more bulky, somewhat similar to those of *Python molurus*, but larger, 22  $\mu$  by 4  $\mu$ . Nucleus median and very large, 9  $\mu$  by 4  $\mu$ . Host-cell sometimes slightly distorted, nucleus pushed to the periphery.

HÆMOGREGARINA REFRINGENS Sambon.

Abstr. P. Z. S. 1907, p. 17 (March 26).

*Habitat.* Erythrocytes of Hoary Snake, *Pseudaspis cana* L.

Crescentic, bean-shaped, and discoidal forms occur. The slender crescentic forms have a long, oval, and more or less central nucleus. The bean-shaped forms measure 10-12  $\mu$  in length by 5-6  $\mu$  in width; they have a wide central nucleus, and their cytoplasm is literally crammed with rounded, highly refractive granules. Host-cell unaltered beyond occasional displacement of nucleus.

HÆMOGREGARINA MANSONI Sambon.

Abstr. P. Z. S. 1907, p. 17 (March 26).

*Habitat.* Erythrocytes of Testaceous Snake, *Zamenis flagelliformis* L.

Oval or bean-shaped cyst 12-13  $\mu$  long by 5-6  $\mu$  broad, enclosing club-shaped parasite doubled up in the form of a letter U with both branches of equal length and closely applied. Nucleus median and situated near bend at one pole of cyst. Chromatin arranged in transverse parallel lines or in concentric circles. A characteristic feature is the almost constant presence of two large chromatoid granules usually placed one on each side of nucleus. Host-cell unaltered, nucleus slightly displaced.

HÆMOGREGARINA RAREFACIENS Sambon.

Abstr. P. Z. S. 1907, p. 17 (March 26).

*Habitat.* Erythrocytes and leucocytes of Couper's Snake, *Coluber corais* var. *couperi* Holbr.

1. Slender, elongate, cylindrical forms 14  $\mu$  long by 1.5  $\mu$  broad, sometimes presenting a refringent granule or vacuole at each extremity. Host-cell apparently unaltered or only slightly hypertrophied.

2. Large bean-shaped forms 12-13  $\mu$  long by 4-5  $\mu$  broad, with cytoplasm more or less granular and occasionally vacuolated. Nucleus small, round, median, with fine chromatin grains. The host-cells containing this form measure about four times the normal size, and are entirely dehaemoglobinized and greatly attenuated. Their nucleus is hypertrophied. Sometimes two or even three parasites may be found in the same host-cell.

3. The Rudd Exploration of South Africa.—VII. List of Mammals obtained by Mr. Grant at Coguno, Inhambane. By OLDFIELD THOMAS, F.R.S., F.Z.S., and R. C. WROUGHTON, F.Z.S.

[Received February 21, 1907.]

No part of South Africa was more inadequately represented in our National Museum than the Portuguese territories north-east of Delagoa Bay, and we are glad to say that the fine collection from Inhambane of which we now give an account does much towards filling up the lacunæ. Mr. Grant found a good collecting place at Coguno, about 75 miles to the south-west of the town of Inhambane, and obtained there the whole of the present series, which numbers 212 specimens, belonging to 39 species.

Of these we have described 6 as new, several of them being particularly striking forms, notably a *Gulago* and a *Petrodromus*.

And besides the novelties, specimens that are of very special value are the topotypes of such of Peters's species as were described from Inhambane, these being the first of a series of Petersian topotypes which we hope Mr. Grant may in time be able to complete, since all S.E. African Mammalogy seems to circle round the species obtained during the epoch-making voyage of the famous German zoologist, and but little satisfactory work can be done until good modern specimens of all his species are available for study.

As before the whole of this valuable collection is presented to the National Museum by Mr. C. D. Rudd.

Mr. Grant's notes on the Inhambane District are as follows:—

"Inland from Inhambane the country is composed of more or less undulating, sandy flats, densely bushed and timbered; often for many miles the only open spaces are the clearings made by the natives for their kraals and cultivated lands.

"Some of the river-valleys are more open, consisting of patches and stretches of forest alternating with open plains, generally thickly covered with palmetto.

"The rivers, excepting the Intanime, are merely huge, dense reed-beds, through which the actual watercourse is often traceable only with difficulty.

"The natives are very numerous and are mostly Melopee, with a small sprinkling of Machangaan, and all are great hunters and trappers, and gave considerable help throughout the trip, either by giving information as regards species or in bringing in specimens.

"My head camp lay close to the Commando of Coguno, which is about 130 kilometres by the Panda Road from Inhambane; thence short trips and excursions were made into the surrounding country as necessity demanded.

"Owing to the denseness of the bush and the comparative flatness of the veldt local guides were always necessary.



"So far as I could learn, the District has never been surveyed, so that the altitude of Coguno, or other places, is unknown, but probably no part exceeds 1000 ft. The actual position of rivers and localities can only be roughly estimated.

"Throughout my stay the climate was delightful; the average temperature being around 80° in the shade, occasionally reaching 88°; it being the dry season, there was little rain.

"The following species were not obtained but exist at Coguno, and the native names may be of interest. They are:

" <i>Lutra</i> .....	Shalu.
" <i>Mungos gracilis</i> .....	Lengo.
" <i>Thryonomys swinderenianus</i> ...	Shleti."—C. H. B. G.

### 1. *PAPIO PORCARIUS* Bodd.

Flat skin.

"Native name, 'Infeni.'

"This species was not seen in the neighbourhood of Coguno Camp, but is said to be common to the North and West. The flat skin sent was obtained from a native who killed it some 20 miles to the northward of my camp."—C. H. B. G.

### 2. *CERCOPITHECUS PYGERYTHRUS ERYTHRARCHUS* Peters.

♂. 1492, 1594. ♀. 1493, 1599.

Mr. Pocock informs us that he considers Peters's *erythrarchus*, of which these are topotypes, should be ranked as a subspecies of *pygerythrus* F. Cuv.

"Native name, 'Makaku' or 'Ihow.'

"Common and inhabiting the denser forests where it lives on the wild fruit and berries. Never observed in large troops; single old males were sometimes seen, but were usually unapproachable. They are at all times wary and extremely difficult to secure. *Cercopithecus albigularis* exists in the district, but is very rare and local and even the natives were unable to obtain specimens; it is known to them as 'Glanglanu'."—C. H. B. G.

### 3. *GALAGO GRANTI*, sp. n.

♂. 1617, 1618, 1619, 1660, 1662. ♀. 1517, 1653, 1663.

A member of the *moholi* group, with an unusually bushy black-tipped tail.

Fur fine and soft, about 15 mm. in length on the back. General colour above drab-brown, rather darker than Ridgway's "drab." Under surface cream-buff, the basal three-fifths of the hairs slaty. Light nose-line and black orbital patches as in *G. moholi*. Outer side of fore limbs light drab, lightening to white on the hands; inner side like belly. Hind limbs as usual dull cream-buff throughout, rather duller than on the belly. Tail long, unusually bushy, the hairs attaining a length of 20-25 mm., those of true *moholi* but little more than half this length; in colour the basal three-fifths of the tail is drab-brown like the body, gradually darkening terminally to blackish brown.

Skull readily distinguishable from that of *G. moholi* by its much longer muzzle, the palate-length being over 17 mm., as compared with 15 in the type of *moholi*, and all the other muzzle measurements in proportion. The bullæ also are lower and less abruptly swollen anteriorly, and the canines appear to be rather heavier.

Dimensions of the type:—

Head and body 158 mm.; tail 237; hind foot 63; ear 43.

Skull—greatest length 45 mm.; basal length 35; zygomatic breadth 28; mastoid breadth 23.5; tip of nasals to back of orbits 25; palate-length 18; front of canine to back of m<sup>3</sup> 15.6.

*Type.* Adult male. B.M. no. 6.11.8.7. Original number 1662. Collected 26 August, 1906.

This Galago differs from *G. moholi* by its long bushy black-tipped tail and by its markedly longer muzzle. Peters's *G. mosambicus*, the skull of which is figured by him under the name of *senegalensis*, has a short muzzle as in the true *moholi*.

With regard to *G. conspicillatus* I. Geoff., Prof. Trouessart kindly informs us that the tail of the type is only 20 mm. in total breadth, therefore exactly as in *moholi*, not as in the Inhambane species.

We have had great pleasure in naming this interesting little "Bush-baby" after its captor, Mr. C. H. B. Grant, who has collected the whole of the immense number of mammals recorded in the present series of papers, and has thus ably utilised the splendid opportunity afforded him by the generosity of Mr. Rudd.

"Native name, 'Suwanjati.'"

"Common and inhabiting the forests. It is strictly nocturnal, sleeping during the day in the hollow trees, where it may generally be taken in small family parties. This species like many others is eaten by the natives.

"*G. crassicaudatus* was several times heard calling in these parts at night, and I saw one skin worn by a boy; none, however, could be secured by myself or the natives, although I offered good rewards for a specimen. It is known to the natives as 'Gerile'."—C. H. B. G.

#### 4. SCOTOPHILUS NIGRITA Schreb.

♂. 1577, 1578, 1621, 1656. ♀. 1579, 1616, 1665, 1671, 1672, 1673.

In this series there would seem to be two forms distinguished by size. The larger corresponding closely to, if not identical with, the specimens from Klein Letaba provisionally identified by Thomas & Schwann (P. Z. S. 1906, p. 577) as *nigrata*. The presence in one place of two forms differing in size seems to be a common occurrence in this group, as for instance, *planirostris* and *viridis* of Peters from the Zambesi Valley, and *nigrata herero* and *damarensis* of Thomas from S. W. Africa. We are of opinion that it is safer to include all these specimens provisionally under *nigrata* until the group can be worked out in its entirety.

"Native name, 'Mongavilane.'

"Quite the commonest of the Bats at Coguno. Generally appears long before dark, flying fairly high, and can be easily secured with a shot-gun. Numbers 1621 and 1673 appeared to me different from the others, from which they were easily distinguishable on the wing."—C. H. B. G.

5. *SCOTOPHILUS SCHLIEFFENI* Peters.

♂. 1595, 1631.

This is the most southern locality from which this small *Scotophilus* has been recorded, the next being Marungu, whence Dr. Noack described his *S. minimus*.

6. *GLAUCONYCTERIS PAPILIO* Thos.\*

♂. 1580, 1603. ♀. 1620.

Additional specimens of the rare and remarkable Butterfly-bats of the genus *Glauconycteris* are extremely welcome. The present examples agree in size and the colour of their heads with *G. papilio*, and equally differ from the white-headed and white-bellied *G. variegatus* Tones, of Damara-land.

"Native name, 'Mongavilane.'

"Apparently uncommon, as the three specimens taken were the only ones observed. They appear about the same time as *Scotophilus*, but have a more butterfly-like flight, which easily distinguishes the species at a good distance."—C. H. B. G.

7. *PIPISTRELLUS NANUS* Peters.

♀. 1668.

Quite like the specimens from Legogot mentioned in the last paper on the Rudd Collections (Thomas & Schwann, P. Z. S. 1906, p. 780).

"Native name, 'Mongavilane.'

"These little Bats were fairly common, but, owing to their small size and rather late appearance, a big series was not obtainable."—C. H. B. G.

8. *AMBLYSOMUS OBTUSIROSTRIS* Peters.

♂. 1635, 1637, 1670. ♀. 1649.

"Caught in run in thick bush."

These valuable specimens are practically topotypes of Peters's species, which was described from the neighbourhood of Inhambane town.

Their bellies are of a peculiar coppery brown, and the lighter basal portion of their dorsal hairs is also strongly tinged with the same colour. In *A. chrysillus* Thos. & Schw., from Delagoa Bay the same parts are white or yellowish white. The hairs of the back are about 5 mm. long in *A. obtusirostris*, 6.5 mm. in *A. chrysillus*.

\* Ann. & Mag. N. H. (7) xv. p. 77, 1905.

"Native name, 'Tukunve.'

"Fairly common and forming runs just below the surface in the sandy ground, in the forest and bush. Owing to the peculiar nature and smallness of the runs it was found impossible to trap it and it could only be taken when seen working."—C. H. B. G.

9. *PETRODROMUS SCHWANNI*, sp. n.

♂. 1521, 1523, 1536 1539, 1557. ♀. 1500, 1515, 1522, 1524, 1537, 1538, 1552, 1553, 1554, 1555, 1556.

Allied to *P. sultan*\* Thos., but skull shorter and the tail more hairy and more finely scaled.

General characters as in *P. sultan*, the peculiar round-headed bristles underneath the tail quite as in that species. Colour similar throughout, except that the dull russet-brown dorsal area is broader and more diffused, extending nearly across the back, instead of forming a comparatively narrow line down the spine sharply separated from the grey of the shoulders and flanks. Face-markings, limbs, and under surface all quite as in *sultan*.

Tail rather longer than in *sultan*, and the scaling finer, 13 rings of scales to the centimetre instead of 10 as in *sultan*; upper surface well haired throughout, the scales nearly or quite hidden—in *P. sultan* the upper side of the tail is practically naked and the large scales are clearly visible). In colour the upper surface is deep black throughout, and the lower dull buffy, not sharply contrasted; extreme base below pale flesh-colour. Long knob-headed bristles black throughout.

Skull markedly shorter than in *P. sultan*, but the shortening is chiefly in the muzzle, the brain-case being of about the same size. Hinder edge of nasals level with the front of the anteorbital rim, and falling about one millimetre short of the frontal processes of the maxillæ. In *P. sultan* the nasals are of about the same length, but end further forward. P<sup>4</sup> (the fourth tooth from the back) comparatively small and narrow.

Dimensions of the type (measured in the flesh):—

Head and body 192 mm.; tail 181; hind foot 57; ear 36.

Skull—greatest length 53 mm.; basal length 47; greatest breadth 29.5; length of nasals 20; interorbital breadth 9; breadth of brain-case 20; length of upper tooth-series 27; front of p<sup>3</sup> to back of m<sup>2</sup> 11.5.

Type. Old male. B.M. no. 6.11.8.32. Original number 1557. Collected 5 July, 1906.

The occurrence of this handsome *Petrodromus* in Inhambane was already recorded by W. L. Sclater†, who had received a specimen collected there by Mr. H. F. Francis. With only a single specimen, however, he did not think himself justified in distinguishing it from *P. sultan*, and it is therefore placed in the 'Mammals of South Africa' under the latter name.

\* P. Z. S. 1897, p. 43o. Originally published as *P. sultani* by a printer's error, but the mistake was corrected P. Z. S. 1897, p. 928.

† Mamm. S. Afr. ii. p. 155, 1901.

In Herr O. Neumann's revision of the genus\* the primary division of the species is made by the hairiness or nakedness of the upper side of the tail, but the occurrence of this species, obviously a close ally of *P. sultan* but with a hairy tail, shows that this character is of but little importance. We should rather divide the species, as in Thomas's original paper, by the structure of the caudal bristles, in which respect *P. schwanni* agrees with *P. sultan* alone of all the described forms.

No *Petrodromi* of this type have been as yet recorded between Inhambane and the mainland opposite Zanzibar, a distance of some 1200 miles.

We are glad of the opportunity of linking with this fine species the name of Mr. Harold Schwann, who has hitherto been so closely connected with the working out of the Rudd Collection.

"Native name, 'Nyakole.'

"Very common and inhabiting only the dense thickets, where it has regular runs, in which it is easily trapped. It has all the actions of the *Macroselididae*, carrying the tail almost perpendicular when running. Exclusively diurnal and insectivorous."—C. H. B. G.

10. *CROCIDURA SYLVIA* THOS. & SCHW.

♂. 1573.

"Native name, 'Nongi' (without distinguishing species).

"Not common and confined to the reed-beds and swamps along the river-valleys, especially the Inyasuni."—C. H. B. G.

11. *CROCIDURA FLAVESCENS FLAVIDULA* THOS. & SCHW.

♂. 1572, 1574

12. *FELIS OCREATA* Gmel.

♀. 1636.

We hesitate to identify this single specimen with any particular subspecies until the arrival of further specimens from Portuguese East Africa.

"Native name, 'Igoye' or 'Simange.'

"Apparently very uncommon, as the specimen obtained was the only one taken or observed."—C. H. B. G.

13. *VIVERRA CIVETTA* Schreb.

♀. 1567.

"Native name, 'Fungwi.'

"According to the natives common, although I did not observe more than the one specimen, except a couple of skins in the possession of natives. Apparently inhabits the thickest of forests."—C. H. B. G.

\* Zool. Jahrb., Syst. xiii. p. 541, 1900.

14. *GENETTA* sp.

♂. 1566. ♀. 1562.

Allied to *G. letabæ* Thos. & Schw.

"Native name, 'Simba.'

"Not very common and found everywhere, especially near native habitations. This species, with all the cats, is eaten by the natives."—C. H. B. G.

15. *MUNGOS GALERA* Erxleb.

♂. 1645.

"Native name, 'Shikoko.'

"Apparently common and generally living in the reed-beds and swamps; the specimen sent, however, was caught some little distance from water and near a Kaffir kraal, where it was probably on the prowl after a stray chicken. Nocturnal only."—C. H. B. G.

16. *MUNGOS (ICHNEUMIA) GRANDIS* Thos.

♂. 1535.

Whether this animal, the external characters of which are quite as in southern examples of *M. albicauda*, should be treated as one of the subspecies of that form, or whether several of these should be raised to specific rank, is a question which cannot be settled without further material. Immature specimens would be of particular value as the characters rest mainly on the structure of the teeth, which get worn down in adult life.

"Native name, 'Sanganye.'

"By no means common and generally found near habitations, which they visit for the chickens, &c."—C. H. B. G.

17. *MUNGOS CAFER* Gm.

"Native name, 'Shlaushlwa.'

"The flat skin sent was the only one seen during the trip. It is evidently rare, as many of the natives did not know its name and some even had never before seen one. The boy from whom I took it said he caught it in the reedy bed of the Inyamatanda River."—C. H. B. G.

18. *CROSSARCHUS FASCIATUS* SENESCENS, subsp. n.

♂. 1558, 1628, 1654.

"Shot in thick bush."—C. H. B. G.

Much greyer than the true *fasciatus*.

Size rather larger than in Zululand examples of *fasciatus*, approaching that of the Ruwenzori form, *C. f. macrurus* Thos., but the tail not lengthened. General colour conspicuously greyer than in *fasciatus*, the nape, fore-back and flanks of a clear cinereous grey, entirely without fulvous suffusion. The stripes normal in number and position, but the light ones white along

their anterior edge, only becoming a little fulvous posteriorly; in *fasciatus* each light stripe is fulvous anteriorly becoming darker fulvous posteriorly. Head finely grizzled grey, blacker on the top of the muzzle. Ears grey, without fulvous suffusion. Limbs grizzled grey, darkening terminally on the hands and feet to black.

Skull of normal proportions, but the teeth unusually large.

Dimensions of the type (measured in the flesh):—

Head and body 364 mm.; tail 236; hind foot 73; ear 24.

Skull—condylo-basal length 73 mm.; basal length 68; zygomatic breadth 39; palate-length 39; greatest diameter of p<sup>1</sup> 7.4.

*Type.* Adult male. B.M. no. 6.11.8.51. Original number 1628. Collected 13 August, 1906.

This beautiful grey form of the Striped Mongoose may be readily distinguished by the reduction of the fulvous suffusion of the fur, this being only present along the posterior border of each dorsal light band, while in the other forms some trace of it occurs all over the body; the clear grey nape and shoulders of *C. f. senescens* are especially noticeable.

The young specimen no. 1558 is more like the typical form.

“Native name, ‘Gale.’

“Apparently fairly common, but difficult to secure owing partly to its wariness and partly to its often inhabiting the denser parts of the bush. The specimens obtained were shot during native hunts and were taken from troops of perhaps eight individuals. It is distinctly gregarious and diurnal in habits, living principally on coleopterous insects and the eggs and young of ground-breeding birds.”—C. H. B. G.

#### 19. MELLIVORA RATEL SPARRM.

“Native name, ‘Sididi.’”—C. H. B. G.

#### 20. ICTONYX CAPENSIS KAUP.

♂. 1534, 1655. ♀. 1575.

“Native name, ‘Shingemani.’

“Fairly common everywhere, especially near native kraals, where it makes itself a considerable nuisance by stealing chickens. Nocturnal only.”—C. H. B. G.

#### 21. FUNISCIURUS SPONSUS, sp. n.

♂. 1596, 1600, 1608 (yg.), 1609, 1610. ♀. 1547, 1560, 1561, 1611, 1612.

A *Funisciurus* intermediate in size between *cepapi* and *palliatu*s, with the colour pattern of the former and the bright colouring of the latter.

Size rather smaller than in *F. palliatu*s.

Fur of back soft, 12 mm. long; that of tail 30–40 mm.

General colour above grey-brown freely grizzled with very pale buff or yellow; the individual hairs black or dark brown, each

with two rings (one near base and one subterminal) yellowish white; the belly orange-red, the hairs unicoloured to their bases. Head from the forehead backwards coloured the same as the back; face below the eyes, chin and throat orange like the belly. Outer side of limbs coloured like the back, but a strong rufous tinge on thighs; inner side orange like the belly. Tail coloured like the back but with a strong rufous tinge at the sides and below; the individual hairs with two pale rings, each 5 mm. wide, separating three black rings of same width, with a long (10-12 mm.) ferruginous tip.

Skull as in *palliatu*s but decidedly smaller.

The following are measurements of the type (which scarcely differ from those of others of the series). For convenience of comparison corresponding measurements of a normal adult specimen of *F. palliatu*s *ornatu*s Gray from Zululand are added between brackets.

Head and body 197 (200) mm.; tail (circ.) 195 (218); hind foot 41 (45); ear 20 (18).

Skull—greatest length 48 (52) mm.; basilar length 37 (40); zygomatic breadth 28 (30); interorbital breadth 13·5 (15); nasals 13·7 (15·5); upper molar series 8·7 (9·5); bullæ 10·5 (11).

*Type.* Adult female. B.M. no. 6.11.8.63. Original number 1560. Collected 5 July, 1906.

Through the courtesy of Dr. Péringuey we have been able to examine a Squirrel from St. Lucia Bay, Zululand (South African Museum, no. 4361), assigned by Mr. W. Selater\* to *frerei* Gray, under the impression that the type of the latter was obtained by Sir Bartle Frere in Natal. But the typical specimen was received by the British Museum in 1873, about which date Sir B. Frere returned to England from Zanzibar, and he did not go to South Africa till some years later. The type locality "Zanzibar" given by Gray for his "*Macroxus annulatus frerei*" is therefore undoubtedly correct. The Zululand specimen, though paler in colour, agrees in all essential characters with the present species, to which we have no hesitation in assigning it. The range of *sponsu*s is therefore from Inhambane to Zululand, where it coexists with *F. palliatu*s *ornatu*s Gray, and this fact and its smaller size amply justify us in classing it as a distinct species.

"Native name, 'Shintsi.'

"Extremely common and found everywhere in the forests and thickets, especially near native clearings; as many as half a dozen can be seen at one time running about in the trees. The alarm call is a bird-like chatter. It is taken in vast numbers by the natives, with whom it is an especial delicacy."—C. H. B. G.

As we have had occasion to refer to the true locality of *frerei*, we further take this opportunity of recording that, allowing for the fact that it is a young individual, we find on comparison that the type of *frerei* agrees quite closely with the specimens assigned

\* Mamm. S. Afr. ii. p. 7 (footnote), 1901.



by Herr Neumann to his *F. palliatus suahelicus* from the same region, and we have no doubt as to their identity; *suahelicus* Neum. must therefore give way to the older *frerei* Gray.

22. *TATERA LOBENGULÆ BECHUANÆ* Wrought.

♂. 1484, 1488, 1491, 1499, 1531, 1532. ♀. 1483, 1487, 1489, 1494, 1514, 1533.

These specimens, though less pale than typical *bechuanæ* from the Bechuana Desert, are very close to that form. Their receipt from Inhambane is interesting from the point of view of the distribution of the species. The type of *lobengulæ* was described from Matabililand and local races were subsequently named from Kuruman, Matopo, and Salisbury, all places which may be described as on the left bank of the Limpopo. In the collection from the Zoutpansberg District on the right bank, though more than one species of *Tatera* were found, there was no specimen referable to *lobengulæ*. More recently, however, in a small collection from Pietersberg District on the right bank of the Limpopo but much lower down than Zoutpansberg, some specimens scarcely distinguishable from the present series were found. Broadly, however, the area between the Limpopo and Zambesi Rivers would seem to be the home of the species, which takes quite well-marked local forms in various parts of its habitat.

"Native name, 'Singaan.'

"Quite the commonest rat in the district and found everywhere, especially in and around the native clearings."—C. H. B. G.

23. *OTOMYS IRRORATUS CUPREUS* Wrought.

♂. 1583, 1584, 1586. ♀. 1585, 1587, 1588.

These specimens are all young but agree closely with *O. irroratus cupreus* from Zoutpansberg.

"Native name, 'Woti.'

"Not common and only taken in the reed-bed and swamps along the river."—C. H. B. G.

24. *ARVICANTHIS DORSALIS* A. Sm.

♂. 1498, 1519, 1614, 1625, 1626, 1630, 1634, 1647. ♀. 1486, 1607, 1615, 1623, 1633, 1638.

"Native name, 'Maklangane.'

"It is here far commoner than in any locality where I have previously taken it. Found everywhere, both in the forest and bush and the native lands, where it has regular tracks and runs, similar to its congener at the Klein Letaba. Exclusively diurnal."—C. H. B. G.

25. *SACCOSTOMUS CAMPESTRIS* Peters.

♂. 1495, 1505, 1506, 1508, 1509, 1597, 1606, 1629, 1639. ♀. 1479, 1481, 1482, 1490, 1501.

These specimens are practically topotypes of *S. fuscus* Peters,

described from Inhambane, but as they are indistinguishable from *S. campestris*, it seems probable that *fuscus* was based on a dark coloured specimen and represents no more than an individual variation.

"Native name, 'Sikwikle.'

"Very common and frequenting the native lands and the adjacent bush."—C. H. B. G.

## 26. *MUS RATTUS* L.

♂. 1520, 1526, 1527, 1551, 1581, 1652, 1657, 1658. ♀. 1528.

"Native name, 'Tikonso.'

"Very common and confined to the kraals and houses, never apparently visiting even the adjacent cultivated land. Several other examples besides the specimens sent were seen and all were very small in size. Apparently exclusively nocturnal."—C. H. B. G.

## 27. *MUS COUCHA* Smith.

♂. 1497, 1502, 1511, 1512, 1605, 1624, 1666. ♀. 1480, 1504, 1648.

"Native name, 'Supwisne.'

"Common and habits similar to those of members of the species in other parts of S. Africa."—C. H. B. G.

## 28. *MUS CHRYSOPHILUS* de Wint.

♂. 1507, 1510, 1513, 1529, 1548, 1601. ♀. 1530, 1540, 1541, 1549, 1550.

"Native name, 'Sinse.'

"Common; habits similar to those of members of the species in other parts of S. Africa."—C. H. B. G.

## 29. *THAMNOMYS ARBORARIUS* Peters.

♂. 1604, 1643. ♀. 1644.

"Native name, 'Shikoloveta'

"According to the natives this species is fairly plentiful, although they were unable to get me specimens; the three secured being the only examples I saw. It is arboreal in habits, forming, according to native report, nests similar to *Dendromus* or *Th. dolichurus*."—C. H. B. G.

## 30. *LEGGADA MINUTOIDES* A. Sm.

♂. 1490.

"Native name, 'Senbendenyumbe'

"Apparently rare, as the specimen sent was the only one taken or observed."—C. H. B. G.

## 31. *CRICETOMYS GAMBIANUS* ADVENTOR, subsp. n.

♂. 1632, 1641, 1651. ♀. 1642, 1650, 1659.

Size and general characters as in *gambianus* and *g. viator*; the

body-colour above much as in *viator*. The sharp line of demarcation between the colour of the back and the white of the belly, which is strongly pronounced in typical *gambianus*, and plainly though less markedly so in *viator*, completely absent; the cheeks and flanks lighter than in *viator*, the lower part of the former white like the belly. Otherwise the colour-pattern quite as in *viator*.

Skull in size and other essential characters as in *viator*; but the upper molar series rather stronger, the anteorbital foramina slightly broader, and the rudimentary postorbital processes more distinct.

Dimensions of the type:—

Head and body 358 mm.; tail 438; hind foot 71; ear 40.

Skull—greatest length 75 mm.; basilar length 65; zygomatic breadth 36; nasals  $32 \times 11$ ; interorbital breadth 11.8; palatal foramina 8.6; length of upper molar series 11.

*Type.* Adult male. B.M. no. 6.11.8.125. Original number 1632. Collected 14 Aug. 1906.

These specimens are from the S.E. limit of the range of the species, and it is consequently not surprising to find such small differences as those recorded above between this and the Nyasa form, from which it is separated by nearly two degrees of latitude.

“Native name, ‘Sigwinye.’

“Fairly common and generally found in thickets and densely wooded places, where it forms burrows of 2–6 holes, almost indistinguishable from those of *Pedetes cafer*. It is exclusively nocturnal in habits, and usually is only to be obtained during the dark phase of the moon; on moonlight nights it seldom comes out, owing, according to the natives, to its great fear of the larger owls. During the dark nights it lays in a store of food to tide it over the moonlight nights, until it can again venture out. I have observed that it also loosely fills the entrance of the burrow with dead leaves during the time the moon is visible. It is a vegetarian, and in search of food often climbs shrubs and small trees. A great article of food with the natives.”—C. H. B. G.

### 32. *PEDETES CAFER* Pall.

♂. 1569 (immature).

“Native name, ‘Masengwi.’

“Not very common, and apparently somewhat locally distributed. Habits similar to its congeners in other parts of S. Africa, forming the usual burrows in the more open forests, never in the thickets where *Cricetomys gambianus* is usually observed. They were extremely wary and difficult to trap and bad luck was experienced with them, inasmuch as in several instances only the toes were left in the trap and in one case the black end of the tail. ‘Majengwi’ was the name given to this species by the natives at the Klein Letaba, hence this is an added proof of the existence of the Springhaas in that locality.”—C. H. B. G.

33. *LEPUS CAPENSIS AQUILO*, subsp. n.

♂. 1518, 1542, 1563, 1565. ♀. 1568, 1667, 1669.

A Hare of the *capensis* group with the nuchal patch grey, and the chin, chest, and belly snowy white.

Fur long, soft, and very fine, length on middle of back about 25 mm. General colour of upper surface "broccoli-brown" tinged with "drab-grey," becoming lighter and gradually suffused with buffy on the flanks. Individual hairs divided into five rings of the following colours and approximate dimensions:—proximal ring "grey no. 9," 7 mm. in length; second ring very pale ecru-drab, 5 mm.; third ring jetty black, 4 mm.; fourth ring light pinkish buff, 6 mm.; distal ring black, 3 mm. Individual hairs of belly about 30 mm. in length, soft, silky, and entirely snow-white. Nostrils and lips edged with white, muzzle and vibrissate area between wood-brown and isabella colour; a broad line extending from upper edge of orbit to within half an inch of muzzle, and thence spreading downwards over lower region of cheek sandy grey; infraorbital area between wood-brown and isabella colour. Eyes ringed with white; forehead coloured like back. Ears distinctly smaller than in the other subspecies, with the proectote\* coloured like forehead and back, fringed with yellowish-buff hairs intermixed with white; metentote sparsely covered with minute white hairs, outer fringe snowy white, absent terminally; metectote white, the terminal margin black. Nape-patch between "smoke-grey" and "drab-grey." Interramia white. Throat-patch "pinkish buff." Chest and belly snowy white. Outer side of fore and hind limbs deep buff, becoming lighter and interspersed with white on fore and hind feet. Tail short, compactly haired, not loose and struggling as is generally the case in specimens of *ochropus*, black above, white below.

Skull as in true *capensis*.

Dimensions of the type (measured in the flesh):—

Head and body 472 mm.; tail 95; hind foot 113; ear 92.

Skull—greatest length 85.5 mm.; basilar length 70; zygomatic breadth 40.1; nasals, oblique length 38.2; brain-case breadth 28.0; diastema 24.4; palatal length 36.0; palatal foramina 22.7; upper molar series 14.7; antero-posterior diameter of bulla 11.3.

*Type.* Male. B.M. no. 6.11.8.132. Original number 1565. Collected 6 July, 1906.

This subspecies may be distinguished from *L. ochropus* by its white chin and chest and the buffy colour of its flanks, in contrast with the yellow of the latter on the sides and nape. It can be easily separated from *Lepus capensis centralis* and *L. c. granti* by their having a vinaceous buffy or pinkish buffy chest and flanks. It bears more superficial resemblance to *L. c. capensis* however, but is distinguishable by having a white chest and chin and a white border *surrounding the tip of the ear*, instead of, as is usual,

\* Thomas, P. Z. S. 1905, vol. ii. p. 359 (1906).

the terminal portion edged with black. A comparison with a considerable series of all the forms mentioned above shows that examples of the present subspecies have a considerably shorter tail and ears than is usual in any of them. Further material will probably show that intergradation takes place between this form and *L. ochropus*, in which case the latter will take its place in the group as a subspecies.

"Native name, 'Nfundla.'

"Common everywhere, especially in the valley of the Inyasuni. Generally lying up during the daytime in the clumps of small bush or grass, and feeding throughout the night, when they can be taken with a noose on the numerous footpaths. Numbers are caught by the natives in this way, the animal being with them a staple article of food."—C. H. B. G.

#### 34. POTAMOCHÆRUS CHÆROPOTAMUS NYASÆ Maj.

♀. 1870.

In its strong ferruginous colouring this specimen quite agrees with examples from Zomba, B. C. Africa, to which Dr. Forsyth Major has given (P. Z. S. 1897, p. 367) the subspecific name *nyasæ*.

"Native name, 'Ngulubi.'

"Plentiful in the thickets and dense forests, but extremely difficult to secure. Always observed in pairs, and more or less nocturnal in habits. When pursued, they savagely attack the dogs, repeatedly charging until killed by the hunters."—C. H. B. G.

#### 35. CEPHALOPHUS NATALENSIS A. Sm.

♂. 1613. ♀. 1485, 1675.

"Native name, 'Mungulwi' or 'Munguli.'

"Not common, and found in the dense forest and thickets, which the 'Nhlengane' loves; even there it is locally distributed, seeming to confine itself to certain patches, from which it never wanders far. Only one or two others, besides the specimen sent, were observed, they were not however secured."—C. H. B. G.

#### 36. CEPHALOPHUS GRIMMI L.

♀. 1503, 1582, 1640.

"Native name, 'Munti.'

"Not too common, and found both in the river-valleys and the forests, visiting the Kaffir lands at night. Numbers of this and other buck are taken by the natives for food."—C. H. B. G.

#### 37. RAPHICERUS NEUMANNI CAPRICORNIS Thos. & Schw.

♂. 1571, 1592. ♀. 1589.

These specimens quite agree with those from Klein Letaba, N.E. Transvaal.

"Native name, 'Isipenu.'

"Fairly plentiful but locally distributed, confining itself to the more open forest and plain, along the river-valleys, away from habitations. Generally observed in pairs."—C. H. B. G.

38. *NEOTRAGUS ZULUENSIS* Thos.

♂. 1627, 1674. ♀. 1525, 1576, 1622.

The examination of these specimens makes it clear that the subspecies *zuluensis* Thos. of the Nyasan *livingstonianus* is quite constant in the essential characters in which it differs from the latter, and we think ourselves justified in regarding *zuluensis* as a distinct species.

"Native name, 'Nhlengane.'

"Very common at Coguno and the whole country inland, but unknown in the immediate neighbourhood of Inhambane. It inhabits the dense thickets and undergrowth, where it has regular tracks, and is generally observed in twos, and occasionally threes. It can be easily obtained in the early mornings and late afternoons, when it is found out feeding in the more open patches of bush and along the Kaffir footpaths that intersect the thickets in every direction, or by joining a hunt which the natives organise for the special purpose of taking this species for food. It is an extremely difficult buck to see when standing in the thickets, and can often be heard giving a goat-like snort of alarm, although quite invisible at only a few yards distance. The does greatly outnumber the bucks, and it is impossible to make out the sexes in their habitat; a great proportion of the former are killed, and very old examples of the latter are not often obtained."—C. H. B. G.

39. *CERVICAPRA ARUNDINUM* Bodd.

♂. 1591, 1593. ♀. 1646.

"Native name, 'Mhlangu.'

"Observed only in the river-valleys, in many of which they are very plentiful, often being seen six and eight together. In the valley of the Inyasuni, where they are little disturbed, they feed throughout the day, and are remarkably tame. Individual males vary much in the thickness of the neck."—C. H. B. G.

April 9, 1907.

Dr. HENRY WOODWARD, F.R.S., Vice-President, in the Chair.

Mr. R. I. Pocock, the Superintendent of the Gardens, exhibited a photograph and the skull of a specimen of the Manul or Pallas's Cat (*Felis manul*) that had recently died in the Society's Menagerie, and made some remarks on the species.

The specimen (text-fig. 87) was received in exchange from the Zoological Gardens in Calcutta, in April 1906, and died from broncho-pneumonia in April 1907. It was alleged to have come from Tibet. Unfortunately no exact locality was recorded; but since the coloration of the skin and the structure of the skull agree with those of examples from Tibet that have been described,

there is no reason to doubt that the animal was captured in that country\*.

When alive, this Cat differed markedly, both in behaviour and appearance, from most captive examples of the genus *Felis*. The latter, if they happen to be tame, usually evince gratification of notice by rubbing, with tail erect, against the bars of the cage. When wild, they are either contemptuously indifferent to friendly overtures or receive them, crouched in a corner, snarling. The Manul, on the contrary, although not tame enough to be handled or touched, nor sufficiently friendly to rub himself against the bars, showed no fear of spectators and no wish to avoid them. He would boldly and aggressively but silently advance to the front of the cage and, standing on his hind legs, grip the bars with his fore paws, ready to scratch at a confiding hand unwarily placed within reach.

Text-fig. 87.



*Felis manul.*

(From a photograph of a specimen living in the Society's Gardens.)

Like all the small Cats, he was usually very silent. He was never heard to utter the growling snarl and guttural expiratory hiss with open mouth so familiarly associated with irritation

\* Except that the orbits are incomplete behind, the skull closely resembles that of a specimen from Ladak in the British Museum.

of temper in Cats; and the "spit" was a short, sharp sound like "ts," "ts," "ts," projected through nearly closed lips. According to the keeper, Dixon, the "mew" or "caterwaul" was a sound somewhat recalling a combination of the bark of a small dog and the "hoot" of an owl. This was heard on one occasion in reply to the typical "caterwaul" of a female Uganda Cat (*F. ocreata*), when "on heat."

The tail was almost invariably carried with its posterior half upcurled, so that the broad black confluent stripes on the under side of its distal end were in full view from behind. The conspicuousness of this jet-black area was enhanced in a marked degree by his peculiar habit of jerking the end of the tail smartly up and down. The lowness and width of the summit of the head and the lateral "set" of the ears imparted to this Cat an aspect totally different from that of all other species (text-fig. 87). In the latter the inner edge of the ear normally rises obliquely outwards from the top of the head to form, with the outer border, a continuous curve or an acute angle. But in *F. manul* the inner border lies normally in the same plane as the top of the head, and meets the vertical outer border at a right angle. This border rises from the head at a point on a level with the outer canthus of the eye. Since depression of the ears in Cats is an infallible sign of anger or of predatory excitement, the simulation of this act caused by the low and lateral setting of these organs in the Manul imparts to his face a permanent look of ferocity and unrest, quite unlike the placid aspect of other Cats with their ears normally erect.

So far as the Manul is concerned, one practical result of the lowness of the forehead and the lateral setting of the small ears is the power to peer over the edge of an object, like a rock or a fallen tree-trunk, without depressing and closing the ears, and without showing so much of the cranium as most of the "high-headed" Cats do when so occupied. Other Cats, when watching prey from behind some such point of vantage, always lower the ears so as to make them invisible and, at the same time, partially close them in such a way that quickness of hearing must be interfered with to a greater or less extent. In this, perhaps, may be found the explanation of the peculiar structural features in the head which give the Manul its remarkable physiognomy. Be this as it may, the above-proffered explanation was forcibly suggested by the observation of the living Manul peering over the edge of his sleeping-box and showing a relatively small amount of head above the eyes, the ears at the time being scarcely perceptibly depressed and not in any sense closed.

It has been stated by Gray\*, on the authority of Hodgson, that the pupils of the eyes are linear and erect. This was not the case in the Society's specimen. Under the influence of sunlight the pupil contracted to a small circular or subcircular disk. The iris was yellowish.

\* P. Z. S. 1867, p. 275. This statement probably misled Elliot into having the eyes of *F. manul* in his monograph drawn like those of a domestic Cat.



There was no marked seasonal change in colour, the coat merely becoming thicker in winter than in summer.

Satunin has recently made *Felis manul* the type of a new genus, *Trichælurus* (Ann. Mus. St. Pétersb. ix. pp. 495-506, 1905), being the first to point out in detail the structural peculiarities of the species. Unfortunately he overlooked the fact that Severtzow had already proposed the name *Otocolobus* for the same species (Rev. Mag. Zool. x. p. 386, 1858).

To Satunin also belongs the credit of showing that three distinct forms of Manul are recognisable, each typical of a particular geographical area. To two of these he gives subspecific and to one specific rank.

Substituting *Otocolobus* for *Trichælurus*, his classification is as follows :—

- 1 a. *Otocolobus manul* Pall. (typical form), from Transcaspia, Turkestan, and Siberia to the west of Lake Baikal.
- b. *Otocolobus manul mongolicus* Sat., from Mongolia and Siberia to the east of Lake Baikal.
2. *Otocolobus nigripictus* Hodgs., Tibet.

I have not seen skins of the typical or of the Mongolian forms, but, judging from Satunin's description and the published figures, I should say that the differences between them and the Tibetan form are only of subspecific value. The name for the latter therefore will be *Otocolobus manul nigripictus*.

The Society's specimen of this subspecies presented the following characters :—

Prevailing colour of face grey: some buff below and at the sides of the nose: the eyes surrounded by a greyish-white area which is bordered by a black streak above and below and partially on the inner side, giving a characteristic spectacled look to the face. The buff area round the nose set off by a black patch, whence arise some black moustachial bristles; the rest of these bristles mostly white and arising from blackish lines on the whitish area of the upper lips. Some black spots running into abbreviated lines on the cheek below the eyes. The two genal stripes broad and jet-black, descending obliquely downwards and backwards, the inferior arising from a spot on a level with the middle of the eye, the superior from a point near the outer canthus of the eye; area above the latter stripe grey, below the former pale grey turning to white posteriorly; the area between them pale greyish white. Posteriorly the two stripes are confluent, and merge below the ear with the sooty-brown hue of the throat and chest. The dark hue of these areas relieved by the long white tips to the hairs. Summit of head black speckled with white; its fore part or the area in front of the ears marked with some small asymmetrically disposed jet-black spots interspersed with a few greyish-white spots. Back of ears greyish, passing

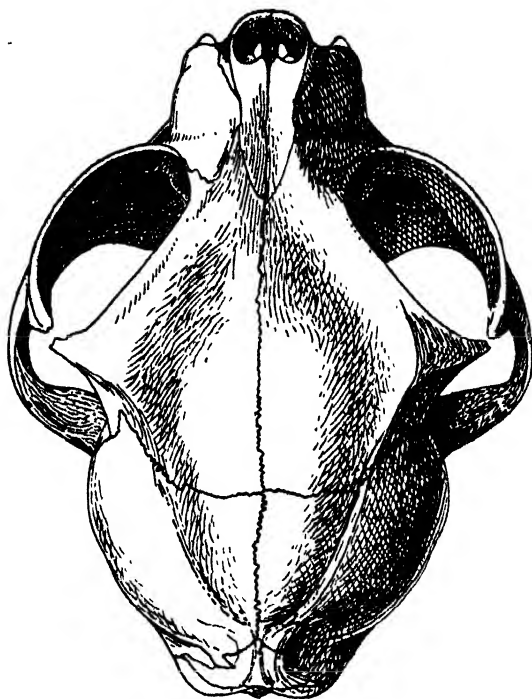
into black towards the head and with a darker rim; hairs on the inner side and in front of the ears whitish grey. Prevailing hue of the dorsal area of the neck and body silvery- or iron-grey, the hairs sooty black basally, then white with a black tip\*. Laterally the dark-tinted basal portion of the hairs is paler in hue and less in extent, the greater portion of the hair below the white sub-apical band being whitish and strongly or faintly tinged with buff, the buff tint showing up strongly when the hairs are parted. On the lower side of the body the hairs have no black tint and the buff tint disappears, leaving the belly and chest white but for a clouding of blackish blotches on the chest behind and between the fore legs. On the lumbar and sacral regions of the back there are traces, mostly very faint, of narrow transverse black stripes. The largest and most distinct of these lies about midway between the shoulder and the root of the tail; on the right side it measures about 57 mm., on the left about 50, the two being separated by a median area of about 20 mm. This is the only stripe that is evident on the right side. On the left side there is one short stripe in front of it, and two abbreviated stripes behind it, one low down on the side, the other higher up and just traceable to the middle line. Behind this there are, on the middle line of the back, three faint transverse blackish blotches, probably representing the dorsal end of stripes. The tail is greyer and paler than the back; in its distal half there are three well-marked black stripes, narrow dorsally and laterally, but expanding and forming a triangular patch inferiorly where they meet. The last stripe fuses laterally and inferiorly with the terminal black tip; and since the expanded areas of the other stripes are only separated by the narrowest intervals, it follows that the distal half of the tail is practically black below. The proximal half of the tail is marked above with three narrow indistinct stripes, which, however, widen and become much more strongly defined below. Fore leg whitish grey turning to creamy buff on the paws; the brachial stripe distinct: other stripes represented by blackish patches. Hind legs with thighs grey like the body, and indistinctly spotted; front of the leg greyish, turning to pale buff on the paws; back of the leg up to the hock rusty cream, a black patch on each side of the paw above the median pad.

Measurement of dressed and flat skin:—Head and body 20 inches (= 500 mm.), tail 9 inches (= 225 mm.).

It is noticeable that the hair of the ventral surface, both on the throat, chest, belly, and thighs, is considerably longer than on the dorsal and lateral surfaces of the body. On the spinal region it measures about 23 mm., and on the belly about 43 mm. The coating of long hairs below is perhaps an adaptation to life in

\* Satunin (*op. cit.* p. 497) says that the hairs on the back and sides have white tips. Did he overlook the slender black tip?

Text-fig 88.

Skull of *Felis manul*, viewed from above. Nat. size.

cold latitudes, where lying or sleeping in the snow is possibly not an uncommon occurrence. In that case the hairs would act as a protection against chill to the delicate internal organs, especially the intestinal portion of the alimentary canal\*.

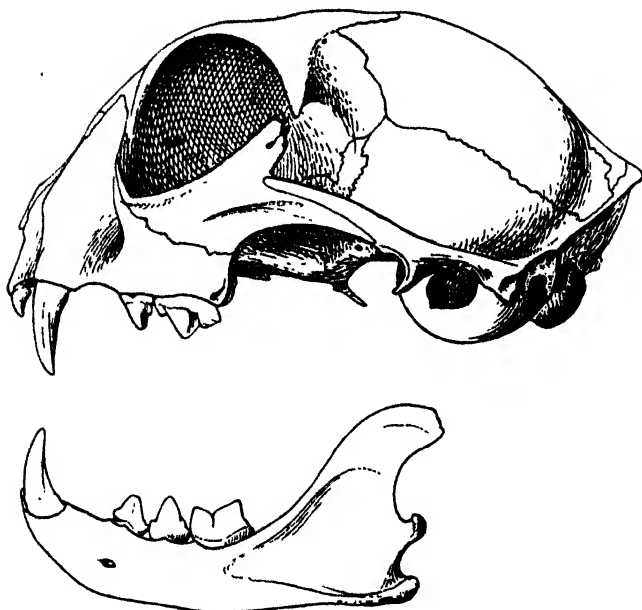
The skull of *F. manul* has been described briefly by Milne-Edwards† and Blanford‡, and more in detail by Satunin, who gives measurements of three examples. The skull of the specimen that lived in the Gardens (text-figs. 88, 89) does not apparently differ greatly from these. The chief peculiarities of the skull may be shown by comparing it with skulls of *Felis sylvestris* and *Felis ocreata*, since *F. manul* is, in my opinion, an aberrant form of the group exemplified by these two species.

\* The ventral development of the hair in the Yak (*Bos grunniens*), also a denizen of cold countries, is a parallel case. The size of the tuft of hair at the end of the tail in this animal perhaps acts as a protection against frost-bite of a part of an organ where the circulation is weakest.

† Rech. Mamm p. 226.

‡ Mamm. Brit. India, p. 83.

Text-fig. 89.

Skull of *Felis manul*, side view. Nat. size.

	<i>F. manul</i> (Tibet).	<i>F. sylvestris</i> (Scotland).	<i>F. ocreata</i> (Suakin).
Total length of skull	85	96	99
Basal length of skull	67	82	83
Width across zygomatica	69	69	72
" across postorbital processes	55	49	54
" behind postorbital processes	41	34	36
" of brain-case	47	47	47
" between orbits	10	20	20
" of muzzle at base of canines	23	25	26
" of muzzle at infraorbital foramina	27	28	28
" between auditory orifices	24	34	32
" across upper carnassials	41	39	40
" of mesopterygoid fossa	12	12	12.5
Length of palate	31	35	36
" from palate to occipital foramen	36	45	46
" of zygomatic arch	43	48	50
" of mandible from condyle	56	64	66
Height from coronoid to angular process	25	30	28
Length of upper carnassial	10	10.5	11.5
" of lower carnassial	8.5	7.5	7.5
Median length of nasals	20		
Width of nasals in line with transverse			
distal edge	9		
" across constriction	6.5		
" just above constriction	7		

Some of the principal differences not shown in the above-given measurements may be described as follows :—

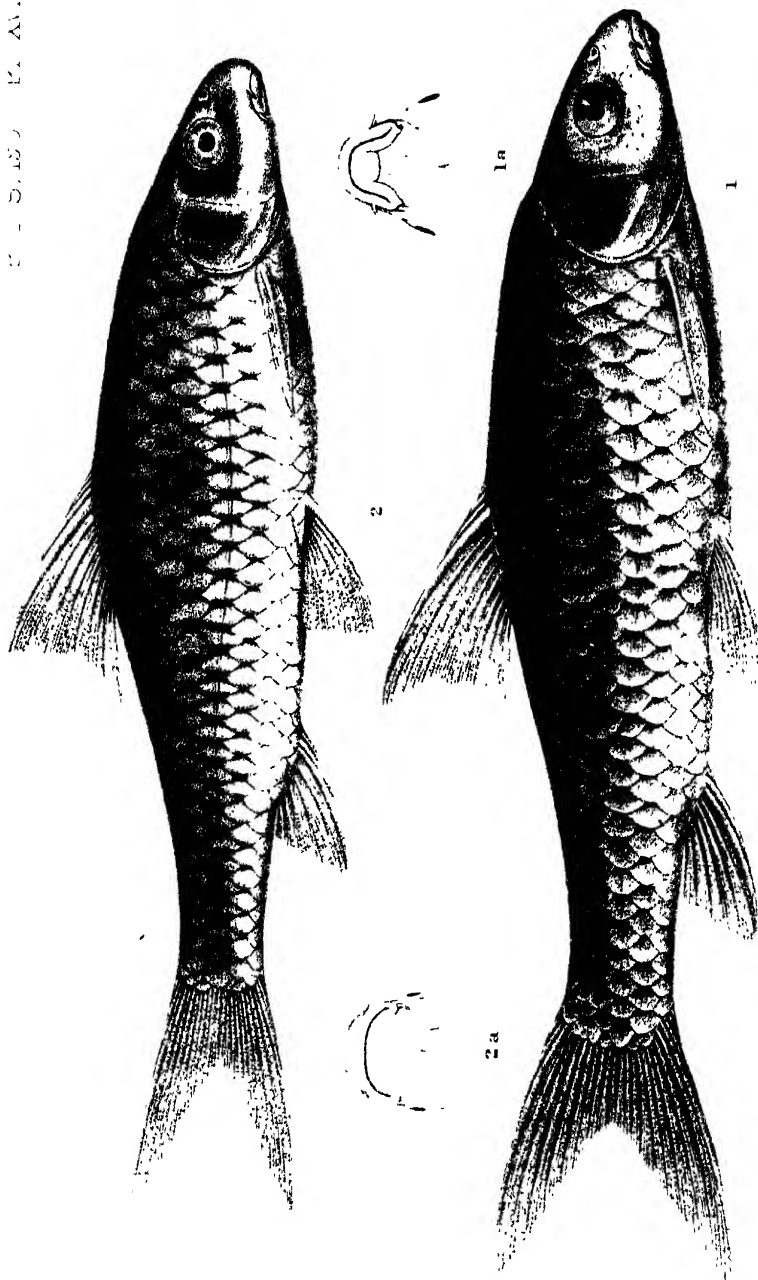
- a. Upper carnassial without inner lobe; no maxillary excrescence bounding the infraorbital foramen above and outside; malar sending up a long narrow process in front of and considerably above the lacrymal foramen; infero-anterior edge of orbit circularly rounded; upper edge of orbit elevated, higher than median portion of frontal bone; facial portion of skull abruptly inclined; occipital crest small; interparietal and parietal crests absent; temporal crests marked by two shallow grooves nearly evenly converging from the postorbital processes to the interparietal; the smooth median and rougher lateral (temporal) area of the parietals slightly elevated and separated by a shallow depression; fronto-parietal suture strongly angled behind the postorbital processes and procurved (concave forwards) dorsally; basisphenoid longitudinally arched..... *manul*.
- b. Upper carnassial with strong inner lobe; a distinct excrescence on the maxilla bounding the infraorbital foramen above and externally; upper process of malar not extending past the lacrymal foramen; infero-anterior edge of orbit more ovally rounded; upper edge of orbit depressed, lower than median portion of frontal bone; facial portion of skull evenly curved downwards from the frontal to the middle of the nasals; occipital and interparietal crests well-developed; temporal crests, when not mesially confluent, represented by a low ridge defining a median lyrate area forming a practically continuous curve with the temporal portion of the parietal bone; fronto-parietal suture forming a nearly straight transverse line; basisphenoid nearly flat, only lightly arched longitudinally.

*sylvestris* and *occreata*.

The skulls of two Tibetan specimens that I have seen do not agree with Milne-Edwards's statement that the nasals in Mongolian specimens are strongly compressed in their posterior and correspondingly dilated in their anterior portion. Satunin also states that the nasals in the Tibet Manul (*F. nigripictus*) differ from those of the typical form in being constricted in the middle and distally expanded. In the skull of the animal in the Society's Collection, the constriction is very slight, amounting to only 1 mm. in transverse width across the two bones. From this constriction the bones expand very gradually forwards and backwards. They may be described as being of the broad type, such as is shown in *F. sylvestris*.

The infraorbital foramen is small and vertically oval, its greatest length being less than the distance between its upper extremity and the superjacent edge of the orbit.





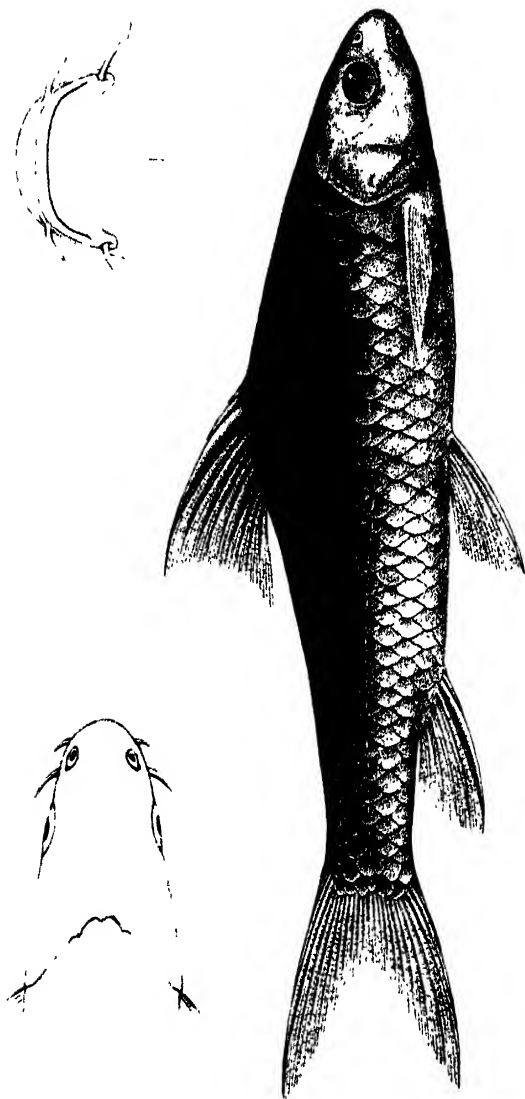
Searle del. et lit.

1. *Parachanna niloticus* (L.)

2. *Green imp.*







5 Green. imp

A H Searle del. et lith.

VARICORHINUS BRUCHII

The following papers were read:—

1. On a small Collection of Fishes made in the Eastern Watershed of the Transvaal by Capt. G. E. Bruce. By G. A. BOULENGER, F.R.S., F.Z.S.

[Received March 12, 1907.]

(Plates XVIII. & XIX., and Text-figures 90, 91.)

When recently serving in the Transvaal, Capt. G. E. Bruce, 5th Mounted Infantry, was so kind as to respond to an application I made to him in 1905, to preserve some of the fishes in which he was interested, and which I felt sure would prove of considerable scientific value, so little being known of the piscine fauna of the Transvaal. I have now the pleasure of drawing up a list of the species represented in a small collection made by Capt. Bruce and presented by him to the British Museum.

The rugged nature and muddy water of the Transvaal rivers, together with the steep banks overgrown by reeds and rushes, make it very difficult to collect, except by fishing with fly or bait, and the laws against netting and dynamite are very strict. Further, the size of the collecting-jars at Capt. Bruce's disposal precluded the preserving of large specimens. Notwithstanding these restrictions, the collection contains examples of several species not previously recorded from the Transvaal, and of five which are here described as new.

#### CHARACINIDÆ.

##### 1. *HYDROCYON LINEATUS* Blkr.

The "Tiger Fish" occurs in the Inkomati and Krokodil Rivers, and appears to be plentiful in all the rivers of the East Coast from the Zambesi to Swaziland.

##### 2. *ALESTES IMBERI* Peters.

New to the Transvaal, where it was found in the Inkomati River at Komati Poort. First described from the Zambesi, it has since been found in Lake Nyasa, in German East Africa, in the Congo, and in Angola.

##### 3. *MICRALESTES ACUTIDENS* Peters.

Inkomati River at Komati Poort. Not previously known from south of the Zambesi.

#### CYPRINIDÆ.

##### 4. *BARBUS RAPAX* Sldr.

Three specimens from Groot Olifant River agree well with Steindachner's description and figure of a specimen from the

Limpopo River, except for the presence of two pairs of barbels. I cannot help thinking that the absence of anterior barbels in the type specimen is due to an anomaly, or that their presence has been overlooked.

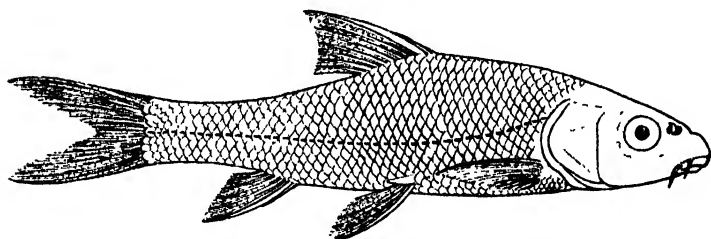
#### 5. *BARBUS EUTANIA* Blgr.

Several specimens from Klein Olifant River. This species, originally described from Angola (*B. kessleri* Gthr. nec Sldr.), has recently been rediscovered in N.W. Rhodesia by Mr. Neave.

#### 6. *BARBUS POLYLEPIS*, sp. n. (Text-fig. 90.)

Depth of body  $4\frac{1}{2}$  times in total length, length of head  $3\frac{1}{2}$  times. Snout rounded-subacuminate, 3 times in length of head, feebly projecting beyond mouth; diameter of eye  $4\frac{1}{4}$  times in length of head, interorbital width  $3\frac{1}{2}$  times; mouth small, inferior, its width 4 times in length of head; lips well developed, lower continuous across chin; two barbels on each side, subequal in length,  $\frac{2}{3}$  diameter of eye. Dorsal III 8, last simple ray strong, bony, not serrated, its rigid part  $\frac{2}{3}$  length of head; free edge of

Text-fig. 90.



*Barbus polylepis*.

the fin strongly emarginate; its distance from posterior border of eye equals its distance from caudal. Anal III 5, longest ray  $\frac{1}{2}$  length of head, not reaching root of caudal. Pectoral  $\frac{2}{3}$  length of head, not reaching ventral; latter below anterior rays of dorsal. Caudal deeply forked, with pointed lobes. Caudal peduncle twice as long as deep. Scales  $43\frac{7\frac{1}{2}}{9\frac{1}{2}}$ , 5 between lateral line and ventral, 18 round caudal peduncle. Olive-grey above, white beneath.

Total length 120 millim.

A single specimen from Klein Olifant River.

In the Groot Olifant River, Capt. Bruce obtained a large *Barbus*, weighing  $3\frac{3}{4}$  lbs., and too large for him to preserve, which, from the notes he has taken, probably represented the adult of the fish here described. Capt. Bruce counted 42 scales in the lateral line,  $8\frac{1}{2}$  in a transverse series above the lateral line, and 6 between the latter and the ventral fin. This large specimen further differed in the much longer rays of the anal fin.

7. *BARBUS HOLUBI* Stdr.

Groot Olifant River.

This fish may be the same as *B. natalensis* Castelnau, insufficiently described.

8. *BARBUS BRUCII*, sp. n. (Plate XVIII. fig. 1.)

Depth of body  $3\frac{1}{2}$  times in total length, length of head 4 times. Snout rounded-subacuminate,  $2\frac{2}{3}$  times in length of head, strongly projecting beyond mouth; diameter of eye 5 times in length of head, interorbital width nearly 3 times; mouth small, inferior, its width  $4\frac{1}{2}$  times in length of head; lips strongly developed, lower continuous and forming a rounded mental lobe; two barbels on each side, anterior not quite  $\frac{1}{2}$  diameter of eye, posterior  $\frac{2}{3}$ . Dorsal IV 9, last simple ray strong, bony, not serrated, its rigid part  $\frac{2}{3}$  length of head; free edge of the fin strongly emarginate; its distance from centre of eye equals its distance from caudal. Anal III 5, longest ray  $\frac{2}{3}$  length of head, not reaching root of caudal. Pectoral  $\frac{3}{4}$  length of head, not reaching ventral; latter below middle of base of dorsal. Caudal deeply forked, with pointed lobes. Caudal peduncle once and  $\frac{2}{3}$  as long as broad. Scales  $29\frac{4\frac{1}{2}}{4\frac{1}{2}}$ , 2 between lateral line and ventral, 12 round caudal peduncle. "Muddy grey above, white beneath; dorsal yellowish grey; caudal and paired fins bright pink."

Total length 150 millim.

A single specimen from the Groot Olifant River.

9. *BARBUS SECTOR*, sp. n. (Plate XVIII. fig. 2.)

Depth of body  $3\frac{1}{2}$  times in total length, length of head  $4\frac{1}{3}$  times. Snout rounded, 3 times in length of head, strongly projecting beyond mouth; diameter of eye 4 times in length of head, interorbital width  $2\frac{2}{3}$  times; mouth inferior, feebly curved, its width 3 times in length of head, lower jaw with a sharp edge; lower lip restricted to the sides; two barbels on each side, anterior about  $\frac{1}{3}$ , posterior about  $\frac{1}{2}$  diameter of eye. Dorsal IV 9, last simple ray strong, bony, not serrated, its rigid part  $\frac{2}{3}$  length of head; free edge of the fin feebly emarginate; its distance from centre of eye equals its distance from caudal. Anal III 5, longest ray  $\frac{2}{3}$  length of head, not reaching root of caudal. Pectoral a little shorter than head, not reaching ventral; latter below middle of base of dorsal. Caudal deeply forked, with pointed lobes. Caudal peduncle once and  $\frac{3}{4}$  as long as deep. Scales  $29\frac{4\frac{1}{2}}{4\frac{1}{2}}$ ,  $2\frac{1}{2}$  between lateral line and ventral, 12 round caudal peduncle. "Muddy grey above, white beneath; dorsal yellowish grey; caudal and paired fins bright pink."

Total length 140 millim.

A single specimen from the Groot Olifant River.

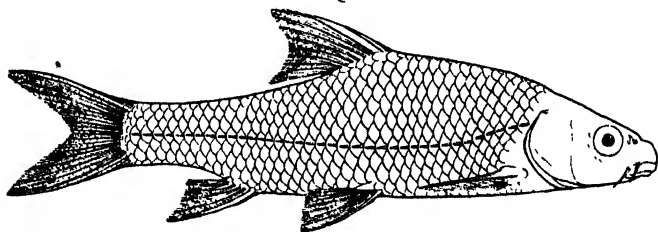
But for the shape of the head and the structure of the mouth, owing to which it should be referred to the genus *Capoeta* of

Günther, this fish could not be distinguished from the preceding. Similar cases of close resemblance between species thus referable to *Barbus* and *Capoëta* have been pointed out by me when describing collections from Morocco and East Africa.

10. *BARBUS ELEPHANTIS*, sp. n. (Text-fig. 91.)

Depth of body equal to length of head, 4 times in total length. Snout rounded, 3 times in length of head, projecting beyond mouth; diameter of eye 4 times in length of head, interorbital width twice and  $\frac{2}{3}$ ; mouth inferior, feebly curved, its width  $3\frac{1}{2}$  times in length of head, lower jaw with a sharp edge; lower lip restricted to the sides; two barbels on each side, anterior  $\frac{2}{3}$  diameter of eye, posterior as long as eye. Dorsal IV 8, last simple ray strong, bony, not serrated, its rigid part  $\frac{2}{3}$  length of

Text-fig. 91.



*Barbus elephantis*.

head; free edge of the fin strongly emarginate; its distance from posterior border of eye equals its distance from caudal. Anal III 5, longest ray  $\frac{2}{3}$  length of head, not reaching root of caudal. Pectoral  $\frac{2}{3}$  length of head, not reaching ventral; latter below middle of base of dorsal. Caudal deeply forked, with pointed lobes. Caudal peduncle once and  $\frac{2}{3}$  as long as deep. Scales  $37\frac{6}{5}$ , 3 between lateral line and ventral, 14 round caudal peduncle. "Muddy grey above, white beneath; dorsal yellowish grey; caudal and paired fins bright pink."

Total length 155 millim.

A single specimen from Groot Olifant River.

Very similar to the preceding species, but distinguished by longer barbels and smaller scales.

11. *BARBUS TRIMACULATUS* Peters.

Groot and Klein Olifant Rivers and Inkomati River.

12. *BARBUS INERMIS* Peters.

Klein Olifant River.

Previously known from the Zambesi only.

13. *VARICORHINUS BRUCHII*, sp. n. (Plate XIX.)

Body strongly compressed, its depth  $3\frac{1}{3}$  times in total length;

length of head  $4\frac{1}{2}$  times in total length. Snout rounded, broader than long,  $\frac{1}{3}$  length of head; eye lateral,  $4\frac{1}{2}$  times in length of head, twice in interorbital width; no conical tubercles on the head; mouth feebly curved, its width 3 times in length of head; two barbels on each side, anterior  $\frac{1}{2}$  diameter of eye, posterior as long as eye. Dorsal IV 9, last simple ray strong, bony, not serrated, its rigid part  $\frac{2}{3}$  length of head; border of fin concave; longest ray a little shorter than head. Anal III 5, not reaching root of caudal. Pectoral a little shorter than head, not reaching ventral, which is inserted below middle of dorsal. Caudal deeply forked, with pointed lobes. Caudal peduncle twice as long as deep. Scales  $31\frac{4\frac{1}{2}}{4\frac{1}{2}}$ ,  $2\frac{1}{2}$  between lateral line and ventral, 12 round caudal peduncle. "Back muddy brown, belly white, fins grey."

Total length 170 millim.

A single specimen from Klein Olifant River. "Lives in deep still pools or under big rocks."

Closely allied to the recently described *V. unsorgii* Blgr., from the Kwango River (Congo System) in Angola, which has a deeper body, a shorter caudal peduncle, and the eyes turned more upwards. This is the fifth known African species of *Varicorhinus*.

#### SILURIDÆ.

##### 14. CLARIAS GARIEPINUS Burchell.

Groot Olifant River.

#### ANGUILLIDÆ.

##### 15. ANGUILLA BENGALENSIS Ham.-Buch.

Groot Olifant River. The specimen is referable to *A. labiata* Peters.

#### CICHLIDÆ.

##### 16. HAPLOCHROMIS MOFFATI Casteln.

Groot Olifant River.

##### 17. TILAPIA NATALENSIS M. Web.

Inkomati River, near Komati Poort.

##### 18. TILAPIA SPARRMANI A. Smith.

Groot and Klein Olifant Rivers.

#### EXPLANATION OF THE PLATES.

##### PLATE XVIII.

Fig. 1. *Barbus brucei*, p. 309.

2. " *sector*, p. 309.

a. Mouth seen from below.

##### PLATE XIX.

*Varicorhinus brucei*, p. 310, with upper view of head and mouth seen from below.

2. On the Winter Habits of the Greater Horseshoe, *Rhinolophus ferrum-equinum* (Schreber), and other Cave-haunting Bats. By T. A. COWARD, F.Z.S.

[Received February 7, 1907.]

In my paper "On some Habits of the Lesser Horseshoe Bat, *Rhinolophus hipposiderus* (Bechstein)" (1) I referred to several points of interest in connection with that species during its winter retreat, and suggested that its congener, the Greater Horseshoe Bat, *Rhinolophus ferrum-equinum* (Schreber), would be found to have similar habits. Since writing that paper I have had the opportunity of observing the Greater Horseshoe in winter in caves in the Mendips, and am fortunate in being able to compare my notes with those made by Mr. Bruce F. Cummings, of Barnstaple, Devon, who at the same time was making observations on the species in the neighbourhood of that town. The conclusions that I arrived at require some modification, but only one of them was not fully confirmed: I said that the bats "usually" occupy different retreats in summer and winter; it would be more correct to say that at times and in certain localities different retreats are used at different seasons, for in the Cheddar caves the bats occupy apparently similar positions in summer and winter. I have, indeed, little knowledge of the habits of the bats in this locality during the summer months, but I found the remains of insects which must have been captured in summer lying beneath places which the bats occupy in winter.

My observations were made at Cheddar, Somerset, and in the neighbourhood, between December 27th, 1906, and January 7th, 1907, and, later, on a few examples in captivity. Mr. Cummings paid a number of visits to some disused manganese mines in the Pickwell Down Sandstone near Barnstaple between December 24th, 1906, and January 23rd, 1907, and also kept one bat alive for some days. At the end of December and beginning of January I found Greater Horseshoes both in the deepest recesses of the caves—some of which are of great length---and close to the entrances, even within reach of daylight.

I regret that I have no accurate record of the temperature in the open at Cheddar during my visit, but on the first few nights there were sharp frosts; later the weather was mild and at entrances of the caves the temperature varied from 40° to 43° F. Within the caves—at some distance from the entrances—the temperature was fairly constant; in different spots I found it between 50° and 52° F., and this I understand is also the summer temperature. Mr. Cummings also found that the temperature in the Barnstaple mines was 52° F.

The dimensions of the caves which I visited vary considerably. The Long Hole, in which I found the Greater Horseshoe abundant, is a long natural tunnel in the limestone of perhaps 150 or 200 yards in length, and with an average width of seven or

eight yards and a height of from five to ten feet; in places the roof is much higher and culminates in fissures and hollows which afford suitable hiding-places for large numbers of bats. The floor is uneven and partially blocked by ancient roof-falls. At the end, beyond a considerable mass of fallen rock, the cavern opens into a small chamber, from which a chimney, blocked by a huge "chock stone," runs upward to a chamber of considerable size. Out of this upper chamber a low passage, in places less than eighteen inches high, extends for some yards; the end of this passage is blocked, and when I examined it no flicker was noticeable in the flame of my candle, but I was informed that at one time it was possible to feel a current of air near its termination, as if it led to some outlet. From the lower chamber a lime-encrusted shaft, running upwards, may lead to further chambers or to the open. During a portion of my visit I was accompanied by Mr. Charles Oldham.

In the Long Hole I found Greater Horseshoes occupying a fissure high up in the roof near the entrance. I cannot say how far within this fissure the bats rested in the daytime, for they were not visible; it was only after dusk that I saw them emerge from some hole in the fissure. I found other Greater Horseshoes scattered singly in the main tunnel, hanging from the roof or in the water-worn holes with which it is abundantly pitted. In the terminal chamber the bats were in colonies of varying size.

In one of the caves of the village, which is open for visitors and illuminated by gas, there is, near the entrance, a wide shaft open to the air. Some ten feet from the floor of the cave, and perhaps fifteen feet from the top of the shaft, a small side-chamber opens out of the wall; the floor of this chamber was thickly covered with old dry dung, mingled with fragments of many beetles, chiefly of the genus *Geotrupes*. Dr. J. Harold Bailey, who kindly examined all my coleopterous fragments, identified portions of *Geotrupes spiniger* Marsh. and of another *Geotrupes*. The Greater Horseshoe, as I shall show later, captures some, and in summer probably all, of its prey outside the caves and conveys it to the interior of the caves before consuming it. The head, elytra, and other portions of the beetles are dropped whilst the bat is crushing the insect in its jaws. This is undoubtedly a common habit, but bats which go far from the caves in search of food may hang to convenient footholds at some distance from their diurnal sleeping-places. In captivity the bats rest after a meal and frequently defecate, a habit which probably accounts for the piles of dung beneath favourite feeding-places in the caves. Both Mr. Cummings and I noticed that our captive bats showed a marked preference for certain resting-places, settling again and again within a few inches of the same spot. This chamber in the shaft was perhaps the only place I came across which appeared to be solely a summer haunt; it may or may not be occupied as a sleeping-place in summer, but it was undoubtedly a chamber to which numbers retired to feed.



Great Oons Cave is longer than the Long Hole; it consists of a rough, slightly descending tunnel and a steep passage running downwards to a considerable depth from the end of the main tunnel. At the bottom of this terminal passage, at a great distance below the entrance of the cave, I found one Greater Horseshoe hanging; a few others and Lesser Horseshoes, *Rhinolophus hipposiderus* (Bechstein), were in other parts of the cave, and a Whiskered Bat, *Myotis mystacinus* (Leisler), was close to the entrance. The Echo Cave is a great cleft in the cliff, entered by a small hole and short passage; the cleft then extends upwards and downwards, the height being over a hundred feet and the width little more than eight feet. Thirty feet or more above the floor of the cave colonies of Greater Horseshoes were hanging from the wall on one side, and a few Lesser Horseshoes were suspended, singly, from the opposite wall. Goutchurch Cavern, on the northern slope of the Mendips, has its entrance high on the hill-side in the treeless valley of Burrington Combe. This cavern consists of long and intricate passages, running far into the hill and descending steeply; here again at a great depth I found both species of Horseshoe scattered about the passages. In other smaller and shallower caves, some with narrow entrances and others with wide mouths, I found Greater and Lesser Horseshoes; one of the former hung in full daylight ten yards from the entrance, and a Lesser Horseshoe from the upper part of a bottle-shaped hollow in the roof only four yards from the entrance.

In no case in which I was able to make repeated observations were the bats actually hibernating. All were susceptible to the disturbance caused by my entrance, drawing themselves up by bending their legs and often swaying slightly, although not touched; bats changed their positions in the intervals between my visits, while others, as I shall show later, flew in the caves without any artificial stimulus and indeed went out into the open air of their own accord. Lesser Horseshoes and Whiskered Bats also moved from positions in which I had observed them, and I saw a Long-eared Bat, *Plecotus auritus* Geoffr., on the wing in the evening in one cave.

On December 29th I carefully noted the position of two Greater Horseshoes in the main tunnel of the Long Hole, one of which was not more than ten yards from the entrance, but was careful not to touch them nor to bring my light near to them. Two days later both had moved. On the same date (Dec. 29th) I found a colony of about forty hanging close together—only a few were actually touching any of the others—in the terminal chamber. Five of these I took without touching any of the others. When pushed from their footholds they fluttered to the ground and lay there, cold and lethargic, but squeaking feebly and extending their legs backwards, apparently in search of some foothold. The remainder drew themselves up by bending their legs but did not unfold their wings. Very little dung lay beneath this colony, and the bats which I took, though they were soon awake and lively,

did not defecate in the box; one taken near the entrance of the cave did so at once.

On the 29th I went into the cave in the afternoon, but on the 31st, when I found that the two bats whose positions I had noted had moved, I entered about 6 P.M. A few yards from the entrance, in a fissure in the roof which may lead to chambers and passages as yet unknown, a thick cluster of wide-awake Greater Horseshoes was suspended from a spur of rock. On the floor of the cave beneath this fissure I had, on the 29th, noted a large pile of dung, but certainly, during the daytime, no bats were visible in the fissure. The bats, which numbered at least thirty and possibly as many as fifty, were clinging together like a swarm of bees; their heads, ears, and facial ornaments were in constant nervous movement and the wings hung loosely by their sides; they had apparently emerged from some crack or hole in the fissure. When I turned the light of a powerful lamp upon the bunch, individuals at once detached themselves, dropped on outstretched wings, and flew further into the cave. On this occasion, so far as I could tell, all flew into the depths of the cave and not towards its mouth. I struck two down with my stick as they flew and could have killed many more; within a few minutes the fissure was empty, all having apparently entered the cave. As I proceeded up the tunnel I found many bats clinging to the walls and roof, their wings hanging loosely, their heads, ears, and nose-ornaments twitching, as with raised heads and necks and hollowed backs they turned and twisted in all directions without moving the position of their feet. Whether these wide-awake bats were or were not able to see me I am not prepared to say, but they were keenly alive to my presence and moved, flying freely, when I approached them. Other bats passed me, flying up and down the tunnel, but it is probable that there is either a second exit or further chambers, for I certainly did not come across all the bats which had left the cluster near the entrance. In the terminal chamber, where on the 29th I had seen about forty bats, only eight remained, and these again were awake; while I was watching them two took wing.

On January 1st, 1907, I went in in the daytime, and not only found that the six bats left on the evening before in the terminal chamber had disappeared but could not see a single bat hanging in the cave. On January 3rd I entered about 6.15 P.M.; no bats were visible in the fissure near the entrance where I had seen the cluster on December 31st, nor were there any hanging and only one was on the wing in the tunnel. The chamber at the foot of the chimney was again empty, but by climbing over the chock stone I reached the upper and larger chamber which I had not previously visited. Here I found two small colonies or collections of bats—numbering twelve and eight individuals respectively—and a single bat in the low passage which leads out of this chamber. These bats were not in profound slumber; some two or three individuals were hanging with the wings by their sides and were

in nervous motion. I took the single bat, but did not touch nor otherwise disturb the colonies.

On January 5th, with Mr. Oldham and my usual assistants I entered the Long Hole about 5.20 P.M.; bats were then dropping out of the fissure near the entrance singly, but there was no cluster as there had been on December 31st. About half a dozen came out and flew inwards. A few were on the wing in the tunnel and the two colonies in the upper chamber were reduced to one company of ten individuals. We again left this colony undisturbed.

In the afternoon, on January 6th, we again visited the upper chamber and found that the number of the bats was further reduced; only four remained. No bats were flying in the cave between 3 and 4 P.M.

We then returned to the fissure, where I had seen the cluster and whence on the previous days we had both seen bats emerge. At 4.20 P.M. a single Greater Horseshoe dropped out of the hole and flew into the cave, and at 4.40 another dropped from the fissure and flew out into the open air. Mr. Oldham then posted himself at the entrance to the cave, in such a position that he could command a view of any bats passing out, while I remained below the fissure. Between 4.40 and 5.20 P.M. at least nine bats came from the fissure or elsewhere and flew out of the cave. A few bats passed us in the tunnel; we could hear the whirr of their wings distinctly, and before it became too dark to distinguish objects at a distance of a few feet—at about 5.30—bats passed and repassed the entrance to the cave, perhaps some of those which had emerged intending to re-enter. So long as there was light it was easy to see the broad wings of the Greater Horseshoes, as they passed out or fluttered past the entrance, silhouetted against the sky.

My visits to the other caves were not so frequently repeated. On December 29th I did not observe any Greater Horseshoes in Great Oons Cave, but I noted the position of two Lesser Horseshoes and a Whiskered Bat without touching them; the Whiskered Bat was clinging to the roof within full reach of daylight. One of the Lesser Horseshoes was sleeping lightly; it partially unfolded its wings, raised its head, and moved its ears, and then relapsed into slumber, refolding its wings. Not one of these three bats, on January 5th, was occupying the position I had seen them in on December 29th, but one Lesser Horseshoe and a Whiskered Bat were in places which were not occupied on the previous visit. We found three Greater Horseshoes, two of which were not at the spots they occupied on January 5th, when I visited the cave on December 29th.

One large cavern was visited on several occasions; on December 31st I could see a number of Greater Horseshoes hanging singly in different parts of the cave, but I only took or touched one; on the subsequent visits I did not see a single bat.

About 7 P.M. on December 31st there were at least thirty or forty Greater Horseshoes, hanging in two companies some

distance apart, from the wall of the Echo Cave; the majority of these bats were awake and others were on the wing. On January 5th the number was smaller; most of these bats were so close together that six were dislodged at once by a stone thrown from below. The Lesser Horseshoes in this cave may or may not have moved in the interval between the visits; they were roughly in the same position on both dates. A Long-eared Bat, which, when handled and replaced in the same position, appeared to be in a deep sleep on the 31st, had gone by the second visit. An unidentified bat was on the wing in the daytime just within the entrance of Wookey Hole, a cave near Wells.

Between December 24th, 1906, and January 23rd, 1907, Mr. Cummings paid seven visits to the old mines near Barnstaple; he arrived independently at the conclusion that the bats were not hibernating and were going outside the caves to feed. He has kindly allowed me to add his notes.

His observations were made at three borings. On December 24th he found a single Greater Horseshoe in No. 1, but none in No. 2; No. 3, the floor of which was under water, was not entered. On December 29th No. 1 was unoccupied, but there were two bats in No. 2 twenty-five yards from the entrance. The bats were not touched, but when, later in the afternoon, he re-entered this boring, he found one on the wing, and the other shortly followed the first out of the tunnel. On January 5th there were again two bats in No. 2. One occupied a similar position to that when first noted, but the other had not returned to the same position. The temperature in the open, on the date of this visit, was high, but rain was falling steadily. The two bats, after Mr. Cummings had taken them out of the tunnel to examine them, and had then returned them to their original positions, were roused and driven out of the cave; they attempted to re-enter the cave three times, but were apparently prevented from doing so by Mr. Cummings's presence at the entrance. Mr. Cummings thought they objected to the rain. Later in the afternoon he discovered two bats, which showed by their manner of hanging with their wings by their sides that they were not in deep sleep; he feels sure they were the bats driven out of No. 2. On January 11th No. 1 and No. 2 were empty, but a small bat entered No. 3 at about 5.20 p.m. and shortly afterwards two Greater Horseshoes came out; Mr. Cummings had, again, not been able to enter No. 3. On January 16th Nos. 1 and 2 were again unoccupied; the temperature in the open was on this and the previous visit 48° F.; within the caves 52° and 53° F. At 5.30 p.m. two Greater Horseshoes, which came from the direction of a deep shaft higher up the slope, passed the entrance of No. 3. On January 19th, when the temperature in the open had fallen to 40° and a cold east wind was blowing, no bats were seen at the mouth of No. 3 between 5.10 and 5.45 p.m., neither were any noticed between 5.15 and 5.45 p.m. on January 23rd, when the temperature at the mouth of the cave was 33°, and it had been below freezing-point all day in the open.

Mr. Cummings, on this evidence, suggests "That the Greater Horseshoe, at the end of December and throughout January, moves freely in the caves, is easily disturbed, and usually hangs at the further end of the boring. That it goes abroad regularly in mild weather, but hibernates more or less deeply in frost, and remains in the caves during rain or high wind."

It has been often asserted that in the Greater Horseshoe and other gregarious bats the sexes hibernate apart; though colonies consisting of bats of one sex only have been found occasionally, both sexes may be found in the same company or cluster. I have found male and female Lesser Horseshoes in the same colony at Cefn, Denbigh, and of the five bats which I took from the forty in the Long Hole on December 29th one was a female and four males. The two bats which I killed as they left the cluster at the mouth of this cave on December 31st were males; four taken from the upper chamber of the Long Hole on January 6th, the remnant of the company of twenty, were males; six dislodged by a stone from a congregation on the wall of the Echo Cave were all males; and five *Pipistrellus pipistrellus* (Schreber), turned out of a crack in the cliff-wall, outside the entrance to the Long Hole, were also males. The single bats found in different places were of either sex, but the majority were males; their ages varied and there were many which, judging by their grey pelage, were born in 1906. I may, of course, have failed to discover the colonies of females, or some of the bats which we did not touch in the colonies may have been of this sex; there is, however, another possible explanation, an inequality in the numbers of the sexes, the males predominating.

The Greater Horseshoe feeds in winter, apparently both within and outside the caves. The floors of all the caves show evidence of the recent movements of bats; in addition to the piles of dung, which were mostly old and dry, fresh excrement was scattered, as if dropped by the bats either when flying or hanging from the roof. Fragments of the prey, in places in small heaps, were also littered about the floors of the caves.

The stomachs of two Greater Horseshoes, killed immediately after capture, contained no food, but that of a third, killed as it flew from the bunch at the entrance to the Long Hole, contained a little and there was faecal matter in the intestine.

Large beetles and moths are apparently the chief food of the Greater Horseshoe. I found elytra of *Melolontha vulgaris* Fabr., and the heads and elytra of *Geotrupes spiniger* Marsh, and perhaps *G. stercorarius* Linn.; these remains were in most of the heaps of dung and were also scattered in the caves; in the Great Oons I found them more than 100 or 150 yards from the entrance. Both species of *Geotrupes* are occasionally abroad in mild weather in winter: we found one *G. spiniger* on horse-dung in the road near the caves; Mr. Cummings finds *Geotrupes* in small numbers throughout the winter at Barnstaple. In the Cheddar caves were the elytra of the flightless beetle, *Nebria brevicollis* Fabr., and at

Barnstaple Mr. Cummings found fragments of a flightless *Pterostichus* (possibly, he thinks, *P. niger* Schall.). The remains of the large cave-spider, *Meta menardi* Latr.—fragments of the cephalothorax with the legs attached in some cases—were present in the Cheddar caves, and Mr. Cummings found remains of a spider at Barnstaple; at Cefn, I found a portion of the leg of a *Meta* in the dung of the Lesser Horseshoe (1). These flightless beetles and spiders must have been picked up by the bats from the ground or taken from the walls. It is not certain that the bats always secure their prey when they are flying, and as the Horseshoes are exceedingly agile on the wing I feel sure that they could, by hovering, pick food from the ground or from a vertical surface, such as the wall of a cave, without alighting; furthermore, in captivity they show a marked tendency to fly low, and will frequently alight with outspread wings upon a flat surface, springing therefrom again with ease.

The wings of *Scotosia dubitata* Linn., a moth which hibernates freely in limestone-caves and was abundant at Cheddar, were scattered here and there, as if eaten recently, and also a few wings of *Gonoptera libatrix* Linn., another species which hibernates, were present. These moths might, of course, have been captured when they were on the wing in summer, but the remains appeared fresher than those of summer-flying moths which do not occupy the caves in winter (for example, *Triphana*) which I found. Mr. Cummings found the remains of both these moths at Barnstaple, and also fragments of two large flies, possibly *Eristalis tenax* and some smaller dipteran. At Cheddar there were many small dipterous insects resting on the walls of the caves; these are soon aroused to activity by the presence of a light. Mr. Robert Newstead found, in dung which he kindly examined for me, remains of certain *Muscidae*, which, as he points out, are all diurnal insects. We do not, however, know at what hours the bats are on the wing in summer, but even if the times when the bats emerge and the insects retire in the evening, or *vice versa* in the morning, do not overlap, the bat which can capture a flightless beetle or spider could take a fly which was at rest.

In Gontchurch Cavern, at a great distance from and below the entrance, I found a dead Staphylinid beetle of the genus *Quedius*; it was damaged by the teeth of a bat.

The prey of the Greater Horseshoe may be captured on the wing, but that it is not, as a rule, devoured whilst the bat is flying, seems to be proved by the behaviour of bats in captivity even more than by the presence of the fragments of prey in the caves. When secured by a snap of the bat's jaws the insect is conveyed to some resting-place and there consumed. Two captive Greater Horseshoes, one of which survived for 14 days and the other for 35 days, were fed almost entirely upon *Geotrupes typhaeus* Linn., the only beetle I could obtain in sufficient numbers in winter. Altogether over 120 beetles were devoured, and in every case the behaviour of the bats was practically the same. I usually

held the bat in my hand until it had snatched the beetle and then released it; but at times the bat, when suspended from some foothold, would take a beetle which was offered to it. The released bat, holding the beetle securely, even if only by one leg, invariably flew to some favourite foothold—usually the picture-rail in one of three different spots, one end of the window-sill, or a curtain-ring—and there hung until the beetle was devoured. When the beetle was dropped in flight, only two or three times in over 120 experiments, the bat made no attempt to recover its prey. I never heard the sound of champing jaws as the bats were flying, but when they were at rest the noise of crushing the hard armour of the beetles was plainly audible.

The interfemoral membrane was never used as a pouch, as it is in the *Vespertilionidae* (2), but the beetle was invariably pushed against the interbrachial membrane, as I observed was the case in the Lesser Horseshoe (1). At times it was thrust against the belly, sometimes into one and sometimes into the other wing, and as a rule one leg was detached from its hold in order to give more freedom to the half-outstretched wing on the same side. The contortions of the bat were most noticeable when it was hanging clear and not against the wall; on many occasions one or other of my captives went through the whole operation when suspended from my finger. The object of this use of the membrane is undoubtedly to prevent the escape of the struggling beetle as the bat relaxes its grip in order to adjust the position of the captive in its mouth; when the beetle was seized by the head, especially if it was a male armed with sharp thoracic spines, it was turned until the bat had a grip upon the abdomen. As the head is thrust into the interbrachial membrane, the wing and leg, on the same side, are moved sharply forward, thus, by the resistance of the membrane, enabling the bat to secure a firmer grasp of the beetle, almost as if the wing was used actually to push the prey further into the mouth. The object of pouching in the *Vespertilionidae* is to prevent the escape of a captive, when the bat is flying, until a firm grip is secured (2), but in the Horseshoes the use of the interbrachial membrane appears to be different; in the *Vespertilionidae* the head is rapidly withdrawn from the pouch and the prey devoured openly; in the *Rhinolophidae* the wing is made use of repeatedly, so long, in fact, as any large portion of the prey projects beyond the jaws of the bat.

The head, prothorax, first pair of legs, and elytra of a beetle are usually dropped by the bat, but occasionally the head or one elytron are devoured; those portions rejected by my captives were similar to many of the fragments found in the caves. When a bat had eaten two or three beetles its head drooped and it lapsed into partial slumber, rousing itself spasmodically at any sudden noise. After a few minutes, however, it would be lively again, swinging round on its legs and moving its head and ears at the slightest sound.

Mr. J. G. Millais states (3) that this species "does not devour

all its food while in flight, but conveys some to its diurnal resting-place": I will go further; it probably conveys all its food to some resting-place. Even when I gave my captives mealworms, insects which are easily crushed by the powerful jaws of a Greater Horseshoe, they were conveyed to some resting-place unless the bat refused to leave my hand. Mr. Millais adds a footnote: "I am quite ignorant as to the manner in which these bats carry their food to their retreats, since the interfemoral pouch seems to be incapable of being bent forward." In no bats, to my knowledge, is the pouch used as a receptacle in which to carry food; the prey is carried, in the most natural manner, in the mouth, firmly secured by the strong teeth. Mr. Millais's statement (p. 30) that the tail is bent forward and the interfemoral membrane occasionally used is probably based on some erroneous observation; it is the inter-brachial and not the interfemoral membrane which is used. During the whole process of pouching and eating the beetle the posterior portion of the tail remains in the recurved position which is so characteristic of the species.

This reflexed tail, or, to be more exact, portion of the tail, is constantly in this curious position. In flight the anterior portion of the interfemoral membrane is stretched between the slightly flexed legs; the end of the tail is upturned; and when the bat is scrambling or climbing the tail is held in the same position; when at rest the tail is flat upon the back if the wings are half open, or lies partially concealed by the forearms if the animal is closely wrapped in its wings.

In sleep the position of the wing-membranes is practically the same as in the Lesser Horseshoe (4), but, as a rule, the bats I found were not so completely encircled by the wings as is the case with the smaller species; the forearms seldom met along the back, whereas in the Lesser Horseshoe one sometimes overlaps the other. In some of the sleeping Greater Horseshoes the tail stood out from the back at an angle of about 30°, in a position I have never observed in the smaller species. Our knowledge of the habits of the *Rhinolophidae* is slight, and as yet we cannot find that the bats gain any advantage from this recurved tail; there is, however, the possibility that the tail is rudimentary.

Occasionally, in captivity, as Mr. Millais noticed, the Greater Horseshoe will sleep with the wings folded along the sides, but this is an unnatural position and is probably accounted for by the impaired health of the captive; when in good health the bats sleep with the interdigital membranes one above the other, in a similar position to that adopted by some, at any rate, of the *Pteropodidae*. The ears, slightly bent or folded, are hidden beneath the carpal joint.

The colour of the adult is brown and does not vary in the sexes, but the young are grey; all the young which I found were naturally much darker than the August young depicted by Mr. Thorburn (5), having more nearly acquired the brown pelage of maturity.



We find, to sum up, the following facts :—

1. The Greater Horseshoe Bat, and apparently in the mild climate of Somerset the Lesser Horseshoe also, if the weather be open at the end of December and beginning of January, is not in a state of hibernation. It moves in the caves, awakening without artificial stimulus, and leaves the caves apparently in search of food.

2. To a great extent the same haunts are used in summer and winter, seeing that numbers of both species are to be found hanging near the entrances to the caves in the winter in situations certainly resorted to during the summer.

3. Both species are susceptible to the presence of a man when they are apparently asleep. They show by their movements—by bending their legs and raising and slightly swaying their bodies—that they are influenced by the disturbance. It appears, from the way in which colonies dwindled in size from time to time, that the bats, after being thus disturbed, though not actually awakening at the time of the visit, retire from the situations they occupied to deeper recesses.

4. Food is conveyed into the caves from without and devoured there, the bats hanging whilst they feed.

5. Certain creatures are captured and eaten in the caves.

6. Creatures incapable of flight are captured by the bats and devoured.

7. When feeding the Greater Horseshoe, like its congener, makes use of the interbrachial membrane and not of the inter-femoral pouch.

The following is the result of Mr. Robert Newstead's examination of the dung and insect remains which I obtained in the Cheddar caves.

Wings of the following moths :

<i>Scotosia dubitata</i> Linn.	}	Probably captured when these insects were hibernating in the caves.
<i>Gonoptera libatrix</i> Linn.		
<i>Triphena orbona</i> Fabr.	}	Captured and conveyed into the caves in summer.
<i>Triphena pronuba</i> Linn.		
<i>Xylophasia polyodon</i> Linn.		

Dry dung, obtained in the summer haunt where I found no bats in winter. 41 pellets minutely examined.

About 68 per cent. contained the remains of Lepidoptera.

"	66	"	"	"	Coleoptera.
"	24½	"	"	"	Diptera.
"	7¼	"	"	"	Arachnida (Spiders).
"	2½	"	"	"	Hymenoptera.
"	2½	"	"	"	Trichoptera.

Of the Coleopterous remains at least 44 per cent. were of *Geotrupes*; in about 12 per cent. there were fragments of *Melo-*

*lontha*; in one pellet there were portions of the elytra of a Geodephagous beetle, possibly of the genus *Amara*, and in another what appeared to be *Dytiscus*.

The fragments of Lepidoptera were difficult to identify, but a number of abdominal segments, scales, hairs, antennæ, eyes, and eggs were from moths of the family *Noctuidæ*.

One pellet was almost entirely composed of the remains of Diptera. Mr. Newstead remarks, "including portions of the wings of a large Muscid with metallic green body, possibly *Lucilia* or allied genus." This green fly was present in seven pellets; the remains of other Diptera were in three or four pellets.

In one pellet was "a portion of the wing of a Hymenopteron remarkably like *Vespa*."

One pellet was entirely composed of the remains of a caddis-fly. In December and January I found a caddis-fly on the wing at Cheddar, and I picked up the remains of one amongst the fragments in the Long Hole.

The spider-remains were of a large species, probably the cave *Meta*; I found remains of this spider, certainly dropped by the bats, in the caves.

Mammalian hairs, probably those of a bat, were present in one pellet.

In 100 pellets, taken from below the fissure in the Long Hole, whence we watched bats emerge, about 48 per cent. of the remains were of *Geotrupes*, and a smaller percentage of a large brown species, possibly *Melolontha*. This dung was dry; we may conclude, not only from the presence of a summer flying beetle (presuming that it was *Melolontha*) but from the condition of the dung and the large size of the heap, that the fissure is occupied in summer.

Fifty pellets taken from a shallow wide-mouthed cave and evidently dropped recently, contained about 98 per cent. of metallic fragments of the abdomen and basal segments of the legs of *Geotrupes*.

One hundred recent pellets from the Long Hole were composed of about 90 per cent. of remains of *Geotrupes*.

It would thus appear that during the winter months beetles of the genus *Geotrupes* form the chief food of the Greater Horseshoe Bat, and that in summer Lepidoptera and Coleoptera are devoured in, approximately, equal quantities.

The following parasites were on Bats which I obtained at Cheddar:—

*Nycteribia hermanni* Leach. From two examples of *Rhinolophus hipposiderus*. Identified by Mr. Percy H. Grimshaw.

*Eschatocephalus vespertilionis* (C. L. Koch). On *Rhinolophus ferrum-equinum*, *Rhinolophus hipposiderus*, and *Myotis mystacinus*. The Ticks, all females, were identified by Mr. A. S. Hirst.

*Spinturnix vespertilionis* (Dufour). This small Mite was present on the wing-membrane of *Rhinolophus ferrum-equinum*, and was identified by Professor E. Trouessart, of Paris, to whom Mr. Hirst had kindly forwarded my specimens.

## REFERENCES.

- (1) COWARD, P. Z. S. 1906, pp. 849-855.
- (2) OLDHAM, Zoologist, ser. 4, vol. iii. pp. 471-474 (1899).
- (3) MILLAIS, Mammals of Great Britain and Ireland, vol. i. p. 27.
- (4) OLDHAM, Manchester Memoirs, vol. xlix. no. 9, pp. 6-7 (1905).
- (5) MILLAIS, *op. cit.* vol. i. plate 1.

3. Notes upon the Anatomy of a Species of Frog of the Genus *Megalophrys*, with references to other Genera of Batrachia. By FRANK E. BEDDARD, M.A., F.R.S., Prosector to the Society.

[Received March 19, 1907.]

(Text-figures 92-100.)

I possess, through the kindness of Dr. Charles Hose of Borneo, an example of a Frog from that country, which at first appears to be referable to the genus *Megalophrys*, and which at least comes nearest to—if it be not identical with—*Ceratophrys nasuta* of Schlegel. It appears to differ, however, from that species in one very important point and in one or two features of minor importance. The single example was in an excellent state of preservation, and I am therefore able to contribute some facts to the anatomy of this genus, which, save for many external characters and certain osteological features, is apparently quite unknown to zoologists. It is necessary, however, to preface my account of its anatomy with an attempt to fix accurately the species to which this account refers. The species *M. nasuta* was originally named and figured by Schlegel\*. Our subsequent knowledge of the external characters of the species is chiefly due to Cantor†, Duméril & Bibron‡, Günther§, Boulenger||, who has summed up and added to the previous descriptions, and, latest of all, Werner¶. Darwin\*\* has figured the heads of *Megalophrys*

\* Handl. Dierk., Atlas, pl. iv. fig. 72. The leaf-like appendage upon the nose is represented as being directed forwards, which is not the case with my example.

† Catalogue of Reptiles inhabiting the Malayan Peninsula &c. Calcutta, 1847, p. 140.

‡ Erpétologie Générale, vol. viii. p. 456.

§ The Reptiles of British India. Ray Soc. 1864, p. 413; Ann. Mag. Nat. Hist. (4) xi. p. 419.

|| B. M. Cat. Batrach. Sal. 1882, p. 443.

¶ "Reptilien und Batrachier aus Sumatra," Zool. Jahrb. (Abth. f. Syst.) xiii. p. 498.

\*\* Descent of Man, 1871, ii. p. 26, fig. 32.

*nasuta* and *M. montana*, regarding them, in accordance with the first and erroneous view of Günther, as male and female respectively of *Megalophrys montana*. Edeling\* has figured the entire animal from above. All of these descriptions, with the exception of that of Boulenger, leave a good deal to be desired in point of details of importance, doubtless because those details were hardly appreciated as important at the time the papers or works in question were written. To Mr. Boulenger's definition, Werner has added a more accurate account of the dermal ossifications, the mere occurrence of which was known to his predecessors. I shall have occasion to refer again to all the above-named writers in the following statement of certain differences which the Frog studied by me shows as compared with *M. nasuta*.

The length of the Frog which forms the subject of the present communication is 135 mm. from snout to vent, a measurement which nearly agrees with that of Werner†, whose description is not sufficiently comprehensive to allow of a confirmation of his identification. The most salient external characters which point to my Frog being identical with *Megalophrys nasuta* are, in correlation with other characters, the long palpebral horn-like appendages and the leaf-like appendage upon the snout. The tympanum moreover is concealed, and the loreal region is excavated. Furthermore, the conical warts agree exactly in their disposition with the descriptions given by Cantor, Günther, and Werner; that is to say, there are three, one on the sacrum median, and a pair anteriorly in the shoulder-region. There are, moreover, three warts upon the head, all of different sizes, arranged in a triangle, the largest occupying the apex of the triangle which is directed backwards. Edeling‡, however, whose figure of the "species" *Megalophrys chysii* is not very good, represents only the sacral wart and nothing of the kind upon the head. Those, indeed, seem to have also escaped the attention of others. No characters of value are introduced into his two descriptions of the species, and it is impossible to be certain of the identity of "*Megalophrys chysii*." The appendages over the eye and on the nose are not of course diagnostic of the genus or species; for in various Hemiphractidae there are similar appendages, and this family is not to be confused with the Pelobatidae. Moreover, Mr. Boulenger has recently§ removed from the genus *Megalophrys* and assigned to the allied genus *Leptobrachium*, *Megalophrys feae*||, a species with prominent palpebral processes, the existence of which doubtless originally influenced Mr. Boulenger in placing the species in that genus. It has also the hard skin upon the back which is mentioned as being more strongly developed in

\* Nat. Tijdschr. Nederl. Indië, vol. xxvii. 1864, p. 265 & plate.

† Günther also (Ann. Mag. Nat. Hist. ser. 4, vi. p. 419) speaks of the frog as 5 inches long. Flower, on the other hand (P. Z. S. 1899, p. 916), gives 90 mm. as extreme length.

‡ Ned. Tijdschr. v. de Dierk. vol. ii. 1865, p. 205, & Nat. Tijdschr. Nederl. Indië, vol. xxvii. 1864, p. 265 with plate.

§ Ann. Mus. Genova, vol. vii. p. 750.

|| *Ibid* vol. v. p. 512.

*M. nasuta* than in *M. montana*. In the example studied by myself, the calcified(?) area formed a continuous plate beginning immediately behind the head, but not continuous with the hardened skin lying over the head, reaching back rather beyond the anterior ends of the ilia. Laterally this area is bounded by a raised glandular fold. On the ventral side of this fold the skin is still hardened, though not so much as dorsally; and this area is again bounded by a narrow raised area quite similar to that just referred to, which separates it from the soft but tubercular skin of the belly. The inner finger is distinctly longer than the second, a character in which this species agrees with *M. longipes*\* rather than *M. montana*†.

It is part of the generic definition of *Megalophrys* according to Mr. Boulenger that the outer metatarsals are united. In

Text-fig. 92.



Palmar surface of hand (upper figure) and foot (lower figure) of  
*Megalophrys nasuta*.

this it differs, according to the same author, from e. g. *Pelobates*, where the "outer metatarsals are separated by web." Having been able to compare my Frog with *Pelobates fuscus*, I find that

\* Boulenger, P. Z. S. 1885, p. 850.

† Id., Cat. Batr. Sal. p. 442.

both frogs agree in the separation by web, only that the web is more extended towards the tips of the toes in *Pelobates*\*. In this, my species apparently agrees with *Megalophrys longipes*. It has, however, a fairly conspicuous inner metatarsal tubercle, but nowhere projecting from the surface of the foot as in *Pelobates*. I found no trace of an outer metatarsal tubercle or of subarticular tubercles. These are absent in *M. longipes*, but described (together with the inner metatarsal tubercle) as "indistinct" in *M. montana* and (by inference) *M. nasuta*.

There are other characters used for systematic purposes in which the individual which I have dissected does not agree with its presumed congeners. The vomerine teeth, which are very few† and form only a narrow band over the projecting region of each vomer, are situated distinctly to the inside of and not behind each choana. And the loreal region is deeply concave, as it is stated to be in *Megalophrys montana* and (by inference) in *M. nasuta* by Boulenger‡, but apparently not in *M. longipes*. As a part of the generic definition of *Megalophrys*, Boulenger uses the form of the tongue, which is described as "subcircular, indistinctly nicked and free behind." In my example of *Megalophrys* the tongue is very faintly§ nicked behind. It is also nearly circular and free behind.

Very important also in fixing the systematic position of this Frog are two osteological characters which have been largely used in defining the genera of Batrachia. The fusion of the sacral vertebra with the ensuing coccyx is a rare feature in Batrachian osteology. It occurs, however, in *Pipa* and among the Pelobatidae. In two genera only, viz., *Scaphiopus* and *Pelobates*, does Boulenger describe the sacrum and coccyx as confluent. They are most unquestionably so in the Frog which I describe in the present communication, and this confluence is incidentally shown in the drawing (cf. text-fig. 93) on p. 332, illustrating the arrangement of certain muscles. This fusion of the sacral vertebra with the coccyx is not only an important classificatory fact if existing systems are to be respected, but raises another fact of greater importance. It is well known that among those genera of Anura in which this fusion occurs, viz. *Pipa*, *Xenopus*, and *Hymenochirus*—the entire set of genera constituting the Aglossa—and in *Pelobates*, *Scaphiopus*, and the present genus among the Pelobatidae, and in *Bombinator* among the Discoglossidae, the apparently single sacral vertebra is really double in the case of *Pipa* and *Pelobates*, formed of three vertebrae in *Hymenochirus*, and of only a single vertebra in *Scaphiopus* and *Bombinator*. It becomes, therefore, a matter of great interest to ascertain what is the arrangement that characterises the sacrum of the species

\* Günther, Cat. Batr. Sal. 1858, p. 136, speaks of the toes of *Ceratophryne nasuta* as "completely free."

† Günther, Cat. Batr. Sal. 1858, p. 136, writes—"Vomerine teeth none."

‡ Cat. Batr. Sal. p. 542.

§ "Tongue entire behind."—Günther.

which I provisionally at least identify with *Megalophrys nasuta*. The most obvious test to apply for the solution of this question is the exit of the spinal nerves. Now I find that a stout nerve issues from the spinal cord just in front of the stout and expanded transverse process of the sacral vertebra; and that an equally stout nerve issues behind this transverse process in the angle between it and the coccyx. There is none between the two. Hence the sacrum is composed of but one vertebra as in most other Frogs.

A second character is the procœlous excavation of the vertebral centra. A part of the definition of *Megalophrys* by Boulenger is "Vertebrae opisthocœlian." This character, used by him in the tabular \* discrimination of the genera of Pelobatidæ, is again made use of in the fuller description of the genus *Megalophrys* †.

It is, however, in the characters of the sternum that this species chiefly differs from other species of *Megalophrys*. Among the characters used by Boulenger ‡ to define the family Pelobatidæ, one is stated as follows, viz.: "The omosternum is constantly present, but small and cartilaginous." That this definition is not absolutely true was subsequently shown by Mr. Boulenger himself §, who asserted that in *Scaphiopus solitarius* there was "no omosternum." The shoulder-girdle and sternum of the genus *Megalophrys* have been figured and described by Parker || in *Megalophrys montana*. The omosternum is minute and the sternum is ossified nearly throughout, an inconspicuous cartilaginous xiphisternum only being left at the free extremity of the bone. These characters (*inter alia*) are used by Mr. Boulenger in his definition of the genus *Megalophrys*, and therefore presumably also apply to *M. nasuta*. Whether the sternal apparatus of *M. longipes* has been examined I do not know. In the Frog upon which I report in the present communication, the characters of the sternal apparatus are different from those which have been referred to in *Megalophrys montana*. Both sternum and omosternum are very well developed.

The omosternum, instead of being a small oval plate of cartilage as it is represented to be by Parker in *Megalophrys montana*, has a form which apart from details is more like that of *Rana esculenta*. It is actually ten millimetres long, and its proportions to the rest of the sternum are therefore much more like those of *Paludicola bibronii* figured by the same author ¶. Although, as in *M. montana* and other Frogs, the procoracoids are bent very

\* Cat. Batr. Sal. 1882, p. 433.

† *Ibid.* p. 442.

§ P. Z. S. 1899, p. 790.

|| A Monograph on the "Structure and Development of the Shoulder-Girdle," Ray Soc. 1868, p. 78, pl. vii. fig. 8.

¶ It is by no means certain in every case that the species described by Prof. W. K. Parker in his Monograph of the Shoulder-Girdle have been correctly identified. I find for example that the sternum of *Hyla cœrulea* (= "*Calamites cyanea*" of Parker's nomenclature) is not as Parker has figured it (*loc. cit.* pl. vii. fig. 6), but exactly resembles the sternum of "*Acrodytes daudinii*" (presumably a *Hyla*) figured by the same author (*loc. cit.* pl. vii. fig. 1).

‡ *Loc. cit.* p. 432.

much forwards, their articulation with the omosternum in *M. nasuta* is not by any means so far forwards as it is figured by Parker in *M. montana*. This articulation is plain enough in *M. nasuta*. Above this articulation and for the entire shaft the omosternum is clearly calcified. It expands above into a circular cartilaginous plate which has a crescentic outline anteriorly and is wider than the shaft. The procoracoidal cartilages at and near both points of articulation with the omosternum are also calcified. The sternum consists of a bony style as in *Megalophrys montana*; but there are differences in detail. In the first place, the bone is longer in proportion to its width in *M. nasuta*, and it does not expand so markedly in width towards its posterior termination as is represented in Prof. Parker's figure of *Megalophrys montana*. In the second place, *M. montana* is characterised by a cartilaginous xiphisternum which "is but little extended either laterally or axially beyond the shaft-bone." This is not at all the case with *Megalophrys nasuta*, where the xiphisternum is a broad and expanded plate, having posteriorly the semicircular cheese-cutter-like outline which is so usual among Frogs. On the whole, therefore, there are some differences between the two species.

The sternum of this Frog is in fact particularly large as compared, for example, to that of its ally *Pelobates fuscus*, with which I have compared it in this and in some other details of structure. The difference of size is, of course, actual in view of the much larger dimensions of the Frog which I describe here as compared with the rather small *Pelobates fuscus*. In *Pelobates* the total length of the body in the individual measured was 47 mm., and the total length of the sternum 16 mm., the sternum being therefore roughly one-third of the length of the body. The corresponding measurements in the Frog described here were 135 mm. and 60 mm., the proportions therefore nearly approaching one-half. The relationship of the sternum to the underlying viscera shows corresponding differences in the two genera. In *Pelobates* the sternum hardly extends back beyond the heart and pericardium which, however, it fully covers. The liver is left largely exposed. In "*Megalophrys nasuta*" the sternum passes a considerable distance beyond the liver-lobes, the heart being beneath almost the commencement of the sternum proper.

So far as I can gather from the memoirs already quoted which deal with the species *Megalophrys nasuta*, there has been no actual description of the sternum in this particular species. But since several systematists use the occurrence of a rudimentary omosternum as a generic definition, the matter must have been looked into by them, or by some of them. So far as present views upon the classification of the Anura go, it is clear that I should be hardly wrong in instituting not merely a new species but a new genus for this Frog, on account of its divergent sternal characters, as compared with those that have already been described in the genus *Megalophrys*. In contradiction, however, to this



conclusion is the extraordinary similarity in detail—I particularly recall the three warty tubercles upon the back and the “nose-leaf”—between this species and *M. nasuta*; but coupled with these are also, as it would appear, differences in features of similar or nearly similar value. Thus the species described here differs from *M. nasuta*, in that the vomerine teeth are within a line joining the choanæ, and that the inner finger is distinctly longer than the second. Again, however, I infer these differences, being unable to find any definite description of the characters in *Megalophrys nasuta*.

The above statement concerning those characters used in the discrimination of genera and species among the Anura seems to me (unless very grave errors have crept into existing descriptions) to show that quite possibly two species have been confused under the name of *Megalophrys nasuta*, which may even be legitimately referred to different genera. I do not propose, however, for the present to give a name to the species the anatomy of which I deal with in the following pages, in case systematists have really had before them, and described, a Frog which is identical with it. But even in this case the foregoing description of external characters is not without use; for some of these characters have been undoubtedly overlooked, or imperfectly described, as in the case of the sternum.

The above account of the systematic characters of the Frog which, on a superficial examination, would be referred to *Megalophrys nasuta* as described by Cantor, Gunther, Schlegel, and Werner, and, I presume, Boulenger\*, may be conveniently summarised for future reference. The following is a restatement of the characters of *Megalophrys nasuta* based upon the single female example of a Frog from Borneo, which, from a survey of the external characters as described by several zoologists, would be referred to that species:—

Length about 5 inches. Head broad and depressed, with loreal region excavated. Tympanum invisible. Long palpebral process over each eye and an upwardly directed leaf-shaped process on the snout. Vomerine teeth few, between choanæ. Tongue sub-circular, very faintly nicked, free behind. Teeth only on upper jaw. Three inequised warts forming a triangle upon posterior region of head. Skin of back indurated, like that of head, to a point behind front ends of ilia. This region separated by a narrow glandular fold from lateral region, also, but more slightly, indurated, which is again separated by a similar fold from the warty ventral surface. Three prominent tubercles upon back, one

\* Mr. Boulenger's recent description (Ann. Mus. Genov. ser. 2, iv. p. 512) of a Frog, referred to the genus *Megalophrys*, and to a new species of the same, viz., *M. fecæ*, which was later (*ibid.* vii. p. 750) removed by him to the genus *Leptobrachium* (with which he also fused the genus *Xenophrys*), seems to show that Mr. Boulenger had not before him at the time when he wrote his 'Catalogue of the Batrachia Salientia' examples of the Frog described by myself in the present communication. For he has mentioned in describing "*Megalophrys*" *fecæ* the fact that the vertebrae are procelous and that they are opisthocelous in *Megalophrys nasuta*.

on each shoulder and one on sacral region. Vertebrae procelous; sacral vertebra fused with coccyx, its transverse processes greatly expanded. No ribs. Omosternum not rudimentary, with calcified style; sternum a bony style, with expanded cartilaginous xiphisternum; shoulder-girdle arciferous. Fingers free; inner finger longer than second. Toes half-webbed; outer toe separated from next by web. Toes not dilated at tips; no articular tubercles; inner metatarsal tubercle extensive but not separated anteriorly from the surface of the foot; no outer metatarsal tubercle.

*Hab.* Borneo.

It will be observed that in the above brief diagnosis I have not attempted to differentiate between generic and specific characters or indeed family characters. That this Frog belongs to the Pelobatidae is quite plain. That it cannot be referred to any known genus—if the present definitions of the same are retained—is also obvious\*. I propose, however, for the present to defer the question of generic distinctness until the Pelobatidae are better known anatomically †.

Whether this Frog is a new species or identical with *Megalophrys nasuta* I must, for reasons already stated, leave uncertain.

### § *Muscles of the Back.*

In the various drawings (text-figs. 93-96) submitted herewith in illustration of the diaphragm of different species of Batrachia, the principal muscles of the back are also shown, and it will be at once seen that these differ considerably in the different forms. Only in *Megalophrys* is it impossible to see these different muscles (text-fig. 98), for the lengthy transverse muscle of the œsophagus and lung almost completely covers them over. When, however, this muscle is divided along its greater length, *i. e.* across the direction of its fibres and the two flaps reflected, the muscles now in question are fully displayed as shown in text-fig. 93. The same muscles are present which are known to exist in *Rana esculenta*, with the possible addition of a muscle not found either in *R. esculenta*, *R. guppyi* (see p. 333), or *R. tigrina*, of which species I have examined the last two. The *Intertransversarii* muscles are well developed and commence from the anterior margin of the greatly expanded transverse process of the sacral vertebrae. They are so well developed that they almost conceal the anteriorly lying transverse processes of the vertebrae, each separate band of muscle joining successive transverse processes being attached near to the ventral median line of the same. The *Ilio-lumbaris* muscle

\* (Footnote added May 8th.) After the reading of this paper, Mr. Boulenger kindly drew my attention to the fact that there occurs in *Pelobates cultripes* a variation in connexion with the fusion or non-fusion of the sacral vertebra with the coccyx ('The Tailless Batrachia of Europe,' Ray Soc. 1897, part i: p. 208). It does not, however, follow that if a character is variable in one species it is not a "good" character in another.

† Schlegel's name *Ceratophryne* cannot be resuscitated; for he first applied it to *C. dorsata*, an American frog which is, I presume, *Ceratophrys dorsata*.

is comparatively unimportant, when those muscles in some other Frogs to be shortly described are considered. As shown in text-fig. 93 its branches to the transverse processes are limited to the outer edges of these. The enormously expanded sacral vertebrae which overlie the ilia give off anteriorly the strongest slip of muscle which I refer to the *Ilio-lumbaris*\* complex. A slender slip of muscle represents the origin of the muscle from the ilium. This arises from the tip of the ilium as it has been described to arise in *Rana esculenta*; but instead of running forward as in

Text-fig. 93.

Part of dorsal musculature of *Megalophrys nasuta*.

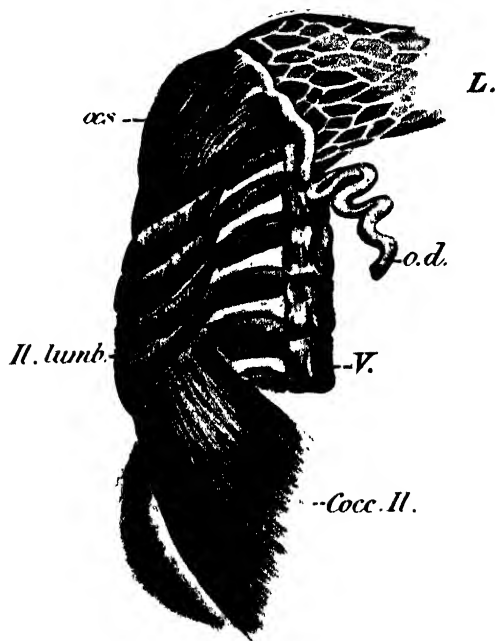
*oes.* Esophageal muscle cut and reflected with oviduct. *Cocc. Ili.* Ilio-coccygeal. *Iliolumb.* Long slip of Ilio-lumbaris muscle compared in the text with the *Musculus proprius pulmonum* of *Pipa*. *S.* Transverse process of sacral vertebra, the fusion of which with the coccyx is shown. To the right of the long ilio-lumbar slip three short ilio-lumbaris are shown overlying the *Intertransversarii*.

that frog, it runs dorsally at right angles to the longitudinal axis of the body owing to the overlap of the sacral vertebra to which it is partly attached. *Megalophrys* differs, as will be seen presently, from a number of other Frogs in the presence of a long, almost strap-shaped and strong muscle which may perhaps be referred to the *Ilio-lumbaris* complex. This arises from the ilium a long way back and is continued straight forwards, without any insertions of detached slips on the way, to the third vertebra, to the outer

\* This corresponds throughout the following descriptions to the "*Pars lateralis*" of Gaupp.

cartilaginous extremity of the transverse process of which it is attached. A flat slip of muscle connects the third vertebra with the second, and is exactly in the same straight line with the muscle just described. It gives the impression of being a portion of it although it is not actually connected. There is nothing exactly comparable to this muscle in any of the genera of Batrachia with which I shall presently deal, with the exception of the allied *Pelobates*. I am inclined, however, to think that it may be the homologue of the "musculus pulmonum proprius" of *Pipa*\*, which the enormous growth of the transversalis in *Megalophrys* has cut off from communication with the aponeurosis of the lung and diverted to the transverse processes of adjacent vertebrae. But this is at present no more than a suggestion.

Text-fig. 94.

Some of the dorsal muscles of *Rana guppyi*.

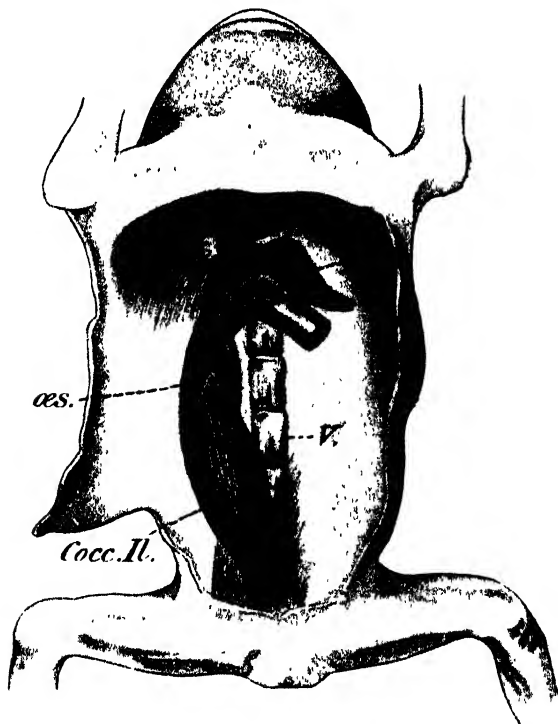
L. Lung. o.d. Oviduct. V. Vertebral centra. Other lettering as in text-fig. 93.

A comparison between the muscles of *Megalophrys* which have just been described and those of *Rana* shows a great number of differences. In *Megalophrys* the Ilio-lumbar muscle complex is

\* Beddard, P. Z. S. 1895, p. 839, fig. 1 m. The transversalis sheet to the lung is not shown in this figure, but is in that of Keith (J. Anat. Phys. xxxix. p. 257, fig. 13 c).

not important as compared with the *Intertransversarii*, that is if the long muscle running from the ilium directly to the third vertebra be put out of consideration. In *Rana guppyi* on the other hand (see text-fig. 94) the ilio-lumbar muscles are very important and occupy a considerable space upon the transverse processes of the ribs. The whole muscle appears to be continuous from the top of the ilium to the transverse process of the vertebra. But it is, though strictly continuous, interrupted by tendinous intersections, each one of these corresponding to a transverse process. These tendinous intersections are of some width. In *Rana tigrina*, which I have been able to compare, the muscle has the same general arrangement; but the tendinous intersections are hardly noticeable. This difference is very possibly merely one of those differences which may be fairly put down to size. In the larger *Rana guppyi* the complication of the muscle is greater than in its smaller ally.

Text-fig. 95.



A dissection of *Pelobates fuscus*, to show large oesophageal sheet of the transversalis. Lettering as in text-figs. 93, 94.

*Pelobates* shows a distinct likeness to *Megalophrys* in the disposition of the muscles now under consideration, as might be

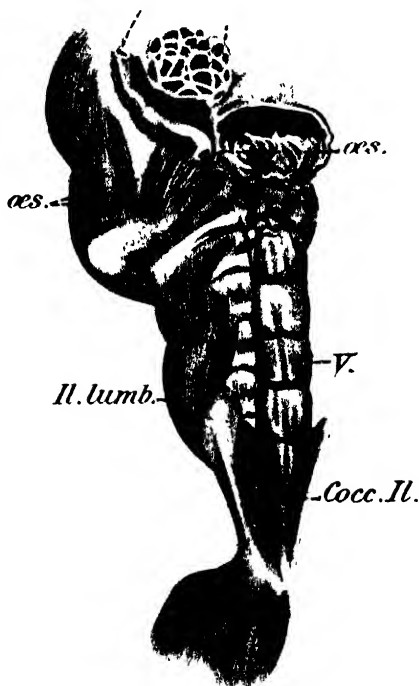
expected from other points of likeness between the two genera, which are referred by some systematists to the same family of Arcifera. The striking feature about the muscles of this region of the body in *Pelobates*, is their very massive development as compared more particularly with *Bufo* and *Ceratophrys*, which I shall deal with later on in this communication. When the viscera are pushed to one side to render visible these various muscles, the ilium and the transverse processes of the vertebræ are nearly completely invisible. The latter indeed are entirely so; but a portion of the ilium is exposed where the massive ilio-coccygeal muscle diverges from it. This is by no means the case with other genera, as the series of figures (text-figs. 93-96) illustrating these facts shows. In this feature again *Megalophrys* comes nearer to *Pelobates*. But in *Megalophrys* the expanded sacral vertebræ are left uncovered; they are quite covered in *Pelobates*.

The strong *Ilio-coccygeal* muscle covers nearly the whole of the ilium, arising up to its very tip. To the inside, *i. e.* towards the centre of the vertebral column, it conceals the commencement of the intertransversarius. The latter muscle is also very strong and thick. Instead of lying between adjacent transverse processes, it is not on their plane at all, but entirely covers them and moreover shows no visible tendinous inscriptions. Quite anteriorly at the second or third vertebra, this muscle finally meets the equivalent of the peculiar muscle described above in *Megalophrys*. That muscle, as in *Megalophrys*, arises in *Pelobates* a long way down the ilium; it is strap-shaped, but relatively stouter than in *Megalophrys*. In front of the ilium it had no attachment to—sent down no slips to—the transverse processes of any vertebræ save the anterior vertebra to which it is ultimately attached. I could detect no ilio-lumbaris other than this muscle, even on removing it from its close contact with the intertransversarius; nor indeed is there much room for one.

So far as the material upon which I am able to report here enables me to say, *Ceratophrys* stands at one end of a series commencing with *Pelobates*, and of which *Rana* is an intermediate member in so far as concerns the muscles of the back which are here dealt with. In *Ceratophrys* the muscular development of this region of the body is but feeble, relatively speaking. The transverse processes of the vertebræ and the larger part of the ilium are quite uncovered by muscles, which are extremely shrunken as compared with those of *Megalophrys* and *Pelobates* and even *Rana*. The same muscles precisely can be recognised and with but little modification. The Ilio-coccygeal is much reduced and arises only from the internal edge of the ilium, commencing some way below the tip of that bone and not extending on to the ventral side. The Intertransversarii are quite separated by the successive transverse processes. There is no continuous band of musculature as in *Pelobates* and, though to a less extent, in some of the other types described here. The Ilio-lumbaris is peculiar as compared with that of other genera: it arises as a thick band of muscle from

near to the tip of the ilium. It forms a continuous mass without tendinous intersections, giving off, however, slips to three transverse processes only, upon the most anterior of which the muscle ends.

Text-fig. 96.

Some of the dorsal muscles of *Ceratophrys ornata*

Lettering as in text-figs. 93 & 95.

In *Ceratophrys* the vertebræ thus supplied by branches of the ilio-lumbaris muscles are Nos. 5, 6, 7; but a few fibres are seen to run on to the transverse process of the fourth vertebra.

*Bufo* closely resembles *Ceratophrys* in all these features. The ilia and the transverse processes of the vertebræ are but little covered with muscle - at any rate in *Bufo marinus* and *B. aqua*, the two species studied by myself. The ilio-coccygeal is, in precisely the same way, a much reduced muscle, commencing its origin some way back upon the ilium and not extending upon the ventral surface of that bone. The ilio-lumbaris is if anything a rather slighter muscle than that of *Ceratophrys*. Otherwise it is exactly similar in its appearance and relations to *Bufo marinus*

(I am not quite certain as to *B. aqua*); its fibres are inserted on to the transverse processes of vertebrae 4 to 7 inclusive. It is from the fourth vertebra in these species that the oesophageal and lung muscles arise (see below, p. 346). In *Rana* also it is from the fourth vertebra.

The resemblance between *Bufo* and *Ceratophrys* in the muscles now under consideration, particularly in their feeble development as compared with the corresponding muscles in some other genera, might be put down to similarity of habit. For *Ceratophrys* is emphatically a 'toad' in its terrestrial habits and lethargic life. I find, however, that there is a close likeness in respect of these various structures between *Ceratophrys* and *Leptodactylus* which is important in view of their inclusion in the same family Cystignathidae by some systematists. I have examined two individuals of *Leptodactylus hexadactylus*, which agree entirely in all the structural features to be referred to immediately. A considerable portion of each ilium is left perfectly free of muscle. As in *Ceratophrys*, but not in *Bufo*, the anterior extremities of the ilia do not reach as far as the transverse process of the eighth vertebra; they extend beyond them in *Bufo*. The ilio-coccygeal commences some little way down the ilium and gives off slips to the transverse processes of vertebrae 4 to 8 inclusive, and the origin of the lung-muscle is confined to the fourth vertebra.

There is not, in fact, much difference in these particulars between *Leptodactylus* and *Rana*. For though in the large *Rana guppyi* the ilium is well covered by the ilio-coccygeal muscle, this is not the case with *Rana tigrina*. And the well-marked tendinous intersections of the muscle in the larger *Rana* are not seen in the smaller species, which thus resembles *Leptodactylus*. In *Ceratophrys* the modifications as to these muscles have gone still further, and it is perfectly clear from the figures (text-figs. 94, 96) that that genus shows marked, though in reality superficial differences from other Frogs, which may perhaps, in view of its likeness to *Bufo*, be looked upon as adaptive. It is, however, perfectly clear that *Megalophrys* and *Pelobates*, though differing from each other in various details, are on the whole much more different from the other genera treated of here than are any of those genera among themselves.

#### § *Muscles of the Ventral Surface.*

In the sternal region of *Megalophrys nasuta* the following muscles are displayed when the skin is removed:—(1) *Pars abdominalis of Pectoral*; (2) *Pars sternalis of Pectoral*; (3) *Pars epicoracoidalis of Pectoral*; (4) *Pars episternalis of Deltoid*; and (5) *Pars scapularis of Deltoid*. As contrasted with *Rana*, the most salient difference shown in this dissection is the very large size of the episternal head of the deltoid, which is as large as, and of course longer than the scapular portion, and together with the epicoracoid head of the pectoral completely hides from view the



*coraco-radialis*. The latter is fully exposed in *Rana* owing to the slenderness of the slip, which represents in that Frog the very large pars episternalis deltoidei of *Megalophrys*.

The *Coraco-brachialis brevis* seems to be exactly as in *Rana*. The coraco-brachialis longus is a double muscle, exposed only by cutting the pars sternalis of the pectoral.

I could not find the pectoro-cutaneous muscles which are so conspicuous in the large *Rana guppyi*.

*Rectus abdominis*.—This muscle arises precisely as in *Rana* from the pelvis, and has here the same conical form, expanding as it does rapidly from behind forwards. Between the two Recti lies the anterior abdominal vein, which is evident until it dips beneath the backwardly prolonged sternum in front. The rectus abdominis has only four *Inscriptiones tendineae*. Three of these lie behind the posterior end of the sternum. The fourth lies beneath the expanded xiphisternum, covered by it, that is to say, when the frog is viewed from the ventral aspect. In *Rana temporaria* there are five of these transverse septa, between the several sections of the muscle. Anteriorly to the first inscriptio tendinea the main mass of the muscle passes without a break, as in *Rana*, into the *sterno-hyoid*. A portion of the rectus muscle, however, just anterior to the origin of the pectoralis abdominalis and largely covered by the obliquus, is separable by a distinct gap and lies at the outside of the main mass of the rectus. This muscular slip ends in a strong tendon which is attached to the rhomboid swelling of the sternum and seems even to reach the coracoid beyond it.

The *Sterno-hyoideus* is rather more complicated than in *Rana*. It is first of all found as the forward extension of the rectus abdominis. From the expanded xiphisternum from its anterior edge - a flat band of fibres runs forward which dip under the tendon of the sternal insertion of the rectus and join the main mass of the sterno-hyoid. There is a third origin of this muscle from the concealed (dorsal) surface of the sternum. The fibres of this muscle arise from further back along the sternum almost from the very extremity of the expanded xiphisternum. The more anteriorly arising fibres form a separate muscle, distinguishable even by a lighter colour, which runs along the inside of the main body of the sterno-hyoid. The insertion upon the body of the hyoid is more extensive than in either *Rana* or *Pelodytes*. The insertions of the two muscles are in contact in the middle line of the cartilage and they extend further anteriorly.

### § *Hyoid and its Musculature.*

The *Hyoid and its musculature* are in some ways peculiar in *Megalophrys nasuta* as compared with those of other Batrachia. On opening the body-cavity, a strong pillar of muscle is seen anteriorly resting on the pharynx on either side. This is the ceratohyal with the enveloping hyoglossal muscle. In *Rana* the

ceratohyal is a continuation on the same plane and in the same straight line of the rest of the hyoid. In *Megalophrys* this part of the hyoid arch is bent down at nearly a right angle with the rest of the hyoid. The close connection of the bone and its ensheathing muscle with the pharynx led me to assume at first an actual anatomical connection between the two. A careful examination, however, shows that there is no such connection, and that the hyoid with the muscle can be raised up from its position which is in actual contact with the pharynx. It is even possible that pressure may be exerted upon the pharynx by the muscle. In the second place, this hyoglossal muscle is very much thicker and altogether stouter than the same muscle in the very much larger frog *Rana guppyi*. As in *Rana*, the two halves of the hyoglossal muscle fuse and become one, and this is continued forward in close contact and on the median line of the hyoid to the tongue.

The *Submentalis* has the usual positions and relations. What is remarkable about it in the present species is that it is actually (and therefore *a fortiori* relatively) larger than the same muscle in *Rana guppyi*.

The *Petrohyoidei* are, as in *Rana esculenta*\*, four in number. As in that frog, the petrohyoideus of *Megalophrys*, arising also from the body of the hyoid, is larger than the three following divisions of the muscle which spring from the bony thyrohyals. The last of these in *Megalophrys* is a large fan-shaped muscle which is not so very much smaller than the anterior petrohyoid. And, moreover, the three divisions of this posterior petrohyoideus muscle are all of fair size, and not merely in contact at their origins (which they are not in *Rana esculenta*), but the middle one actually overlaps the other two. It is important to note that in *Pelodytes punctatus*, according to Ridewood†, the fourth division of the petrohyoid is absent.

The third division of the *Petrohyoideus posterior* arises, it may be remarked, from the inner edge of the thyrohyal and not as the other two from or near the outer edge of this bone, *i. e.*, that facing towards the attachment of the muscles. In *Rana*, Gaupp describes the muscle in question as springing from the cartilaginous epiphysis of the thyrohyal. This is not at all the case with *Megalophrys*, where the epiphysis in question, easily detached, is a relatively long and spur-like plate of cartilage directed outwards and at right angles to the shaft of the thyrohyal. The anterior of the three posterior petrohyoids does not arise from the bony thyrohyal, but from the cartilage at its junction with the body of the hyoid.

The *Omohyoid* appears to show no peculiarities as compared with *Rana*.

The *Geniohyoid* has the usual two origins, and it is to be noted that these are as in *Pelodytes* according to Ridewood, and not as

\* Gaupp's edition of Ecker's 'Anatomie des Frosches,' 1896, p. 139.

† P. Z. S. 1897, p. 579.

*Rana* according to the same observer; that is to say, its origin does not extend on to the tough membrane which lies between the posterior process of the body of the hyoid and the thyrohyal. Nor, in *Megalophrys*, as again in *Pelodytes* but not in *Rana*, is any part of the sternohyoid inserted on to this membrane. The reason for this is clear in the case of *Megalophrys*. For in that Frog the very large posterior petrohyoid completely covers over this space and would allow of the insertion of no muscle upon it.

The *Subhyoideus* (the posterior portion of the submaxillaris of some authors) is rather different in the Frog which forms the subject of the present communication from the corresponding muscle of *Rana*. In the latter it is a hyoidean muscle and arises in the extreme lateral region of the hyoid cornua. In *Megalophrys*, where these cornua are absent, I traced the muscle to the wall of the skull just behind the tympanum.

The *Hyoid cartilage* is not like that of either *Pelodytes* or *Pelobates*, both of them allies of the present genus. Nor does it recall that of *Rana*, for I can find no trace of a cartilaginous cornu principale or hyoid arch proper; and as I have already stated, the subhyoideus muscle arises from the skull-wall and did not serve to guide me to a hyoid bar.

*Xenophrys monticola* obviously comes nearer to my species than any other species of the hyoid of which I can find a description. Of this Frog the late Prof. W. K. Parker wrote\*: "I could find no cartilage in the hyoid arch from the Eustachian opening downwards until I reached the hypohyal region." The outline is very similar to that of *Megalophrys nasuta*. There is towards the upper end of the diverging body of the hyoid (the hypohyal of Parker) a nick in the cartilage on the outer side. This, as I think, represents the nick which I figure here in *Megalophrys nasuta*, and to which what appear to be vestiges of the hyoid arches or ceratohyals are attached. Behind this in *Xenophrys monticola*, as in *Megalophrys nasuta*, the body of the hyoid forms a bay from which arises in my species the anterior petrohyoideus. There is no more trace in *Xenophrys* than in my species of an anterior lateral process of the body of the hyoid, unless indeed the hypohyal really represents that, and the true anterior process of the body of the hyoid is absent. In both these Frogs, however, the posterior lateral process of the hyoid is present, and the thyroid bar is well-developed and ossified, but without the spur-like cartilaginous epiphysis of *Megalophrys nasuta*.

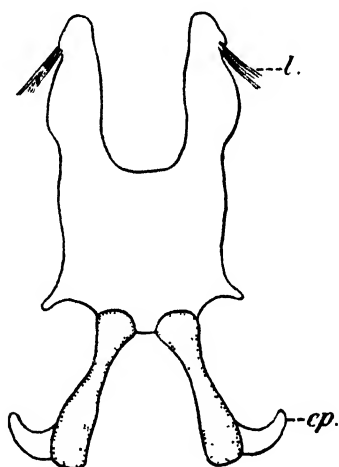
The accompanying figure (text-fig. 97) shows the hyoid of *Megalophrys nasuta*. The body is fairly stout and shows no traces of an anterior lateral process. The anterior, "hypohyal," process on each side is a somewhat spoon-shaped piece of cartilage in the same straight line with the rest of the body of the hyoid. It is not bent inwards as in *Pelobates* and *Pelodytes*†. Nor could I

\* "The Skull in the Batrachia," Phil. Trans. 1881, pl. 23, fig. viii.

† P. Z. S. 1897, pl. xxxv. figs. 10, 12.

find any foramen in the cartilage such as occurs in *Pelodytes*. There was a slight thinning, however, of limited extent at a point just opposite to the divergence of the two anterior prolongations of the body of the hyoid, and corresponding therefore to the marked foramina shown in the two genera *Pelodytes* and *Pelobates* by Dr. Ridewood, whose figures are referred to below, and in *Scaphiopus*\*. If that be so, it would seem to follow that the tract of cartilage lying outside of this is really the remains of the hyoidean cornu, and the apparent solidity of the body of the hyoid due to the complete and secondary fusion of this hyoidean cornu with the body of the hyoid. The weak place in the body of the hyoid is, however, so little marked that I hesitate to give to it this morphological importance, and, moreover, it is covered by

Text-fig. 97.

Hyoid of *Megalophrys nasuta*.

*cp.* Cartilaginous epiphysis. *l.* Ligament representing anterior cornua.

the attachment of the sterno-hyoideus muscle which lies to the inside of the foramen in *Pelodytes punctatus*. More likely to correspond to traces of the otherwise missing hyoidean cornu is, I think, a stout ligament shown in my figure (text-fig. 97) which is attached to a slight indentation near to the anterior end of the anterior prolongation of the body of the hyoid. The position, it will be observed, is by no means unsuitable to such an interpretation of its nature. Nor would this argument be necessarily at variance with the supposition that the thinning on the body of the hyoid in this frog is the equivalent of the foramen in *Pelodytes* and

\* Boulenger, P. Z. S. 1890, p. 792.

*Pelobates*. I could find no splint-bone, such as Ridewood has figured in *Pelodytes* as lying upon the posterior edge of the body of the hyoid among the fibres of the sterno-hyoid muscle whose insertion reaches quite to this edge. The body of the hyoid contained no ossified tracts such as are sometimes met with in this cartilage in other Frogs. The strongly ossified thyrohyals lie, as already mentioned, at a considerable angle with the body of the hyoid. The cartilaginous epiphysis of the same is not a cap at the free end, but is attached to the outer edge and is somewhat curved. It suggests a separate but rudimentary upper element of this branchial arch—if it really be one, and not a mere process of the body of the hyoid. Dr. Ridewood quotes Mr. Boulenger's opinion "that the hyoidean cornua were disjointed in all those genera which he includes in the family Pelobatidae."\* My own results do not enable me to support fully this assertion. I would rather say that among the Pelobatidae the hyoidean cornua are clearly on the road to disappearance. Dr. Ridewood has pointed out several points of likeness between these structures in the *Aglossa* and in the Pelobatidae. I may add that the disappearance of the anterior cornua in *Megalophrys nasuta* and *Xenophrys monticola* is also to be observed in *Pipa*.

#### § *Muscles of Shoulder and Arm.*

The muscles arising from or inserted into the scapula appear to be the same in *Megalophrys* as in *Rana*; for I identified the following, viz.: *Dorsalis scapulae*, *Rhomboideus anterior*, *Rh. posterior*, *Llevator scapulae superior*, *L. s. inferior*, *Cucullaris*, *Serratus superior*, *S. medius*, *S. inferior*, *Interscapularis*, and *Omo-hyoideus*; besides others of which a further account seems to be desirable. There are two of these, viz., the *deltoid*, and a muscle of which I find no account in Gaupp's edition of Ecker, and which I term *scapulo-humeralis*. I have already referred to the *pars episternalis* of the deltoid. The only further point to be remarked upon is the apparently total absence of a clavicular head, which head I found to be very conspicuous in the large *Rana guppyi*.

The *scapulo-humeralis* is a small slender muscle running from the scapula to the neck of the humerus, between the scapular and adjoining humeral heads of the anconeus. I found this muscle in *Rana guppyi*.

#### § *Muscles of Thigh.*

The thigh-muscles of *Megalophrys* are in many respects different from those of *Rana*.

The most salient difference is seen on the inside of the thigh when the skin is removed, and concerns the *Semitendinosus*. This muscle is then evident without further dissection, and is not at all covered by the two *Graciles*. The tendon of insertion of these two latter muscles in fact, instead of passing over the tendon of

\* Journ. Linn. Soc. vol. xxvi. p. 53.

the semitendinosus (that is of course when the thigh is inspected from the inside), passes below it. The arrangement is thus the precise reverse of that which characterises *Rana*.

The *Semitendinosus* is then quite a superficial muscle on the inside aspect of the thigh, visible for practically its whole extent without dissection. In *Rana* it is covered not only by the graciles but by the adductor. The semitendinosus may be termed a two-headed muscle, but there are traces of further subdivision at the origin from the symphysis. The lower (posterior) half of the muscle arises by two closely contiguous heads and is to some extent overlapped by the gracilis major. It ends at about the end of the second third of the femur in a stout tendon which is continuous with the insertion on to the inside of the leg below the knee. The anterior half of the muscle is inserted on to this tendon soon after it is established. There is no common fleshy origin with any part of the adductor mass such as occurs in *Rana*.

Unless the anterior head of the semitendinosus is to be regarded as its equivalent, there is no *Sartorius* muscle. It is important to notice that in the absence of a sartorius and in the superficial semitendinosus, *Megalophrys* not merely differs from *Rana* but agrees with *Pipa* \*.

#### § *The Lungs and the "Diaphragm."*

The *Lungs* of this species are not much less in size than those of the huge female *Rana guppyi*. The suspensory ligaments appear, however, to be rather different and more complex. I shall give some account of them rather as a basis for future comparison, since but little seems to be known concerning these and other peritoneal folds among the Batrachia. Anteriorly the right lung is not in actual contact with the right lobe of the liver; there is a definite and rather broad pulmo-hepatic ligament, such as is plain in *Rana guppyi*. This ligament runs back and at the end of the liver-lobe becomes continuous with the postcaval vein. It is more extensive than as well as rather different from the corresponding ligament in *Rana guppyi*. and, as will be seen presently, extends much further along the lung. This pulmo-hepatic and afterwards pulmo-caval ligament is attached to the edge of the lung mesial. It does not end posteriorly in a crescentic free edge as such ligaments often do. It runs as far as the beginning of the kidney and then bends round and becomes continuous with a ligament attaching the dorsal surface of the lung to the oviducal ligament and so to the dorsal body-wall. There is thus a continuous U-shaped line of attachment, and this traverses the lung nearly from end to end. There is thus a similarity to the conditions observable in most Lizards where there is both a pulmo-hepatic and a dorsal pulmonary ligament. "It may be noted," observed Mr. Butler, who first contrasted † the Teiidae, which do not possess the pulmo-hepatic,

\* P. Z. S. 1895, p. 388.

† P. Z. S. 1889, p. 445 footnote.

with other Lizards which do, "that two similar types occur among the Amphibia. Thus in the Salamander all the membranous attachments of the lungs and liver seem to be precisely similar to those in the common Lacertilian type (e.g. *Lacerta*). But in the Frog the two lungs hang freely suspended on either side, as in the Teiidae." This is clearly not true of *Megalophrys nasuta*. But it is very nearly true of *Rana guppyi*, but not quite true.

In the latter Frog in fact the pulmonary ligaments, which are illustrated in the accompanying drawing (text-fig. 99, p. 349), have the following disposition and attachments. I have examined three examples of this species and all of them females, and the structure of the parts in question only differs slightly from individual to individual. By far the greater part of the right lung hangs freely in the body-cavity, without any attachments to neighbouring viscera or to the parietes. The difference in this particular between *Rana* and *Megalophrys* is quite striking. Towards the root of the lung a ligament runs obliquely across that viscus; it is at first attached to the right lobe of the liver and runs on to the post-caval vein. The arrangement in fact is so far exactly as in *Megalophrys*. But in the latter the line of attachment of this ligament is along the longitudinal axis of the lung, whereas in *Megalophrys* it is more across and at right angles to this axis. Otherwise, and save in the limited extent of the ligament, the two agree essentially in the mode of suspension of the right lung within the body-cavity. The ligament curves down in the same way as in *Megalophrys*, and is connected with the suspensory ligament of the oviduct. The left lung shows the same relative differences. In *Megalophrys* it has a very long line of attachment to the stomach, while this is not the case with *Rana*. In view, therefore, of these differences, it is important to compare this genus with its undoubted ally *Pelobates*. In the latter Frog the ligament attached to the lung extends for more than half-way down that viscus in its contracted condition, and reaches as far back as the liver in its opposite attachment. Thus there is no doubt the Frog which I describe here is more nearly allied in this particular also to *Pelobates* than it is to *Rana*. And there are other likenesses between these genera in addition to those already made use of by systematists.

In the case of *Pipa* and *Xenopus*, the anatomy of which has been recently studied by myself\*, and ten years later by Dr. Keith†, there are muscles which attach the lungs to the parietes. A portion of this complex "diaphragm" is also to be found in the Common Frog, where it consists of a sheet of muscle, a part of the transversalis which ends upon the œsophagus and the roots of the lungs. This has been figured in several places, and the most recent figure known to me is in the latest edition of Ecker's great work

\* *Pipa* in P. Z. S. 1895, p. 827, and *Xenopus*, *ibid.* p. 841.

† "The Nature of the Mammalian Diaphragm &c.," J. Anat. Phys. xxxix. 1905, p. 253.

upon the anatomy of the Frog\*. In this figure the muscle is seen when the frog is examined as lying upon the dorsal surface to rise gradually from the muscular parietes and to end upon the œsophagus near to its dorsal side. It is a strap-shaped, quite flat band of muscle.

In *Rana tigrina*, where I have examined the muscle carefully, and which is a larger species and thus lends itself more successfully to such an examination, the muscle is very obvious and precisely as in *R. esculenta*. Its fibres can easily be seen to end upon the œsophagus. I could not, however, detect the fact—if it be a fact—that some of these fibres cross the œsophagus to be inserted upon the dorsal face of the lung (or rather, of course, its peritoneal sheath). On the other hand, a portion of the muscle in question is inserted upon the cervical aponeurosis, which lies in front of the lungs and heart and shuts off the neck from the trunk. These muscle-fibres pass into the aponeurosis, and may well be attached to the lung ventrally, since they appear to reach the pericardium beyond it.

The large *Rana guppyi* shows an interesting deviation from these diaphragmatic structures in *Rana tigrina*, which I do not think is entirely a matter of greater clearness of visibility owing to its much larger size. It is, as I believe, to be put down rather to the greater complexity in the detailed structure of animals of a large size as compared with their smaller allies. In this Frog the transversalis muscle is precisely as in *Rana tigrina*, save for the fact that two considerable bands of fibres at no great distance from each other raise themselves from the common mass of the transversalis and pass just under the oviduct to the aponeurosis of the lung. It seems to me to be plain that these detached slips correspond to that portion of the corresponding muscle (with a different origin however) which in *Pipa* and *Xenopus* are very conspicuously attached to the lung, as is shown in the figures of Dr. Keith† and myself‡. Except in size and importance there is thus less difference between *Rana* (at any rate so far as concerns *R. guppyi*) and *Xenopus* and *Pipa* as regards the insertion of the “spinal segment of the diaphragm” than might have been inferred. As has been pointed out by Dr. Keith, the dorsal part of the “diaphragm” in *Xenopus* has migrated back§—so at least it would seem—to the ilium from which it arises, and in *Pipa* further back still, *i. e.* to the femur, whence the muscle in question springs in that genus. I have, however, now to record some new facts which tend to throw a doubt upon this interpretation of Dr. Keith.

In *Megalophrys* the transversalis sheet to the œsophagus is a muscle of very great extent; it is, for instance, fully twice the length (not relatively, but actually) of the same muscle in *Rana*

\* ‘Anatomie des Frosches,’ by Gaupp.

† *Loc. cit.* fig. 10, p. 254, & fig. 11, p. 255.

‡ *Loc. cit.* fig. 1, p. 842.

§ These facts were also correctly noted by myself.



*guppyi*. It follows, therefore, that as the general build of these two Frogs, *i. e.* the proportions of the skeleton, is much the same, the origin of the muscle in *Megalophrys* must differ from that of *Rana*. And, as a matter of fact, it does. In *Megalophrys* the muscle runs back into quite the pelvic region, and its posterior part arises actually from the ilium. In respect of this muscle, therefore, *Megalophrys* offers us actually what is a theoretically possible condition in the ancestor of both *Rana* and *Xenopus*. Of a continuous sheet of muscle such as occurs in *Megalophrys*, the anterior part only has been retained in *Rana* and the posterior

Text-fig. 98.



The oesophageal sheet of transversalis muscle in *Megalophrys nasuta*.

*al.* Oesophagus. *Cocc.II.* Coccygeo-iliacus muscle. *h.g.* Hyoglossus. *o.d.* Oviduct. *æ.s.* Oesophageal muscle.

part only in *Xenopus*. A careful examination of this muscle in *Megalophrys* has convinced me that no fibres escape from it on to the lung or any other viscera. Its attachment to the oesophagus, and to the oesophagus only, can be easily followed. The oviducal membrane which it underlies is clear and transparent throughout, with no muscular fibres traversing it.

In view of the interesting differences which the transversalis muscle of *Megalophrys* shows to the corresponding muscle of the

other genera of Batrachia described above, I am particularly glad to have had the opportunity of dissecting, and to be able to record the appearance of, the muscles of this region of the "thorax" in *Pelobates fuscus*; for this genus is referred by Boulenger to the same family, Pelobatidæ, as that which contains *Megalophrys*. That Boulenger's view is more correct than that of Mivart\* and some others, is testified to by the structures of these various muscular arrangements which have been considered in the foregoing pages. The figure (text-fig. 95, p. 334) is a drawing of the interior of the body of a male *Pelobates fuscus*, with such viscera removed as interfere with the proper view of the transversalis muscle. It will be noted that that muscle is very extensively developed and that its origin reaches back not only to the ilium, but for some way along that bone, where it overlaps, but hardly conceals, the coccygeo-iliacus.

The whole of the transversalis muscle in *Pelobates* is obviously fixed to the œsophagus, in which there is a slight difference from *Megalophrys*, where the hinder end of the muscle does not appear to reach the œsophagus but to terminate upon the oviducal membrane. The *Pelobates* however, as I have mentioned, was a male; but the corresponding part of the muscle were it present would naturally lie upon the median mesentery. The muscle is, moreover, at first sight rather reduced in size as compared with that of *Megalophrys*. But a close study shows that this is due to the semilunar excavation of the posterior margin of the same,—that really its origin extends quite as far back as in *Megalophrys*. Moreover, in both of these Frogs the muscle completely covers and conceals the ilio-costal muscles; anteriorly a state of affairs which is not found in *Rana* &c., as is depicted in the accompanying figure (text-fig. 98). In *Pelobates* the distinction between this muscle and that which is applied to the terminal cervical aponeurosis is very marked; their fibres do not show any continuity anywhere. This muscle—the ventral part of the diaphragm, as Dr. Keith terms it—is better developed in *Pelobates* than in *Rana*. There is hardly any membranous portion left. This is plainly shown in the figure.

I have also examined into the condition of this œsophageal sheet of the transversalis in other genera. In the South American *Ceratophrys ornata* the muscle is easy to see and is disposed rather differently from the muscle in the genera that have been already referred to. It is not extensive as in *Megalophrys*; but is, as in *Rana*, limited to the fore part of the visceral cavity. Instead of forming at its origin at any rate a single continuous sheet of muscle, it is in *Ceratophrys* distinctly divided into three portions. The present is one of the species of the genus which possesses a large dorsal ossification in the cutis, which is firmly articulated to the vertebral transverse process, from the surface of which the muscles in question arise. The innermost or posterior of the three

\* "The Classification of the Anurous Batrachians," P. Z. S. 1869, p. 290 &c.

slips (on the right side of the body) is the one which is attached to the œsophagus. It is, as already said, short as in *Rana*, and does not extend far back in the body. The middle slip partly covers this and is of considerably less size, that is to say, breadth, for the length hardly differs. It lies at a different plane from the first slip of the entire muscle, being more ventrally directed in its course. It is attached to the membrane bearing the oviduct, which is in its turn connected with the membrane at the root of the lung. The outermost portion of the muscle is the largest and is chiefly spread over the cervical aponeurosis, a good many of its fibres being directed towards the lung. On the left side of the body of the example of this species which I dissected, there was not quite so marked a distinction between the first two parts of the muscle. There is thus in this species of Frog a very much more marked subdivision of the muscle than exists in *Rana guppyi*, which is perhaps due to, and is at least connected with, the fact that the origin of the muscle in *Ceratophrys* is more spread over the surface of the transverse process, which is moreover enlarged and rather firmly connected with the dorsal scute. This transverse process extends outward far beyond the transverse processes of the vertebræ which follow it. I am at present unable to go into detail; but a dissection of *Bufo agui* and of *Rhacophorus*\* sp., has shown that in these species also there is some specialisation of the slips of muscle passing to the œsophagus and lung.

### § *Alimentary Canal.*

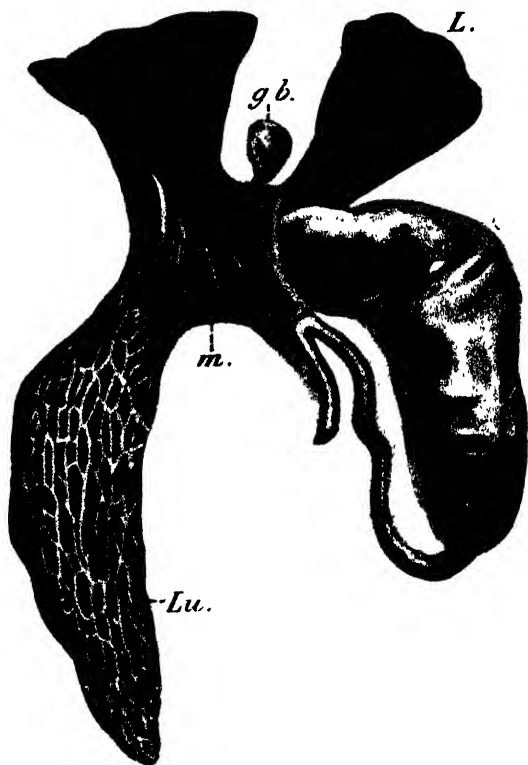
The *alimentary canal* and the *appended glands* of *Megalophrys nasuta* show certain small variations from the structure of those organs in *Rana esculenta* and *R. tigrina*. But the conditions obtaining in *Rana guppyi* (text-fig. 99) prove that the form of the liver, for example, is to be used with caution as a generic character, as do also the variations in the form of this organ in the Common Frog. In *Rana guppyi*, for instance, the two lobes of the liver represent the entire subdivision of that organ. The right and left lobes were not further subdivided in any of the three examples at my disposal. And it may be remarked that three examples selected at random are a very fair test of a characteristic. Moreover, in all of these three specimens the right and left lobes were of approximately the same size. They were connected below the œsophagus by a narrow isthmus of hepatic tissue. Now in the Common Frogs of this country the left lobe is decidedly the larger of the two. In the example of *Rana tigrina* which I dissected the outer of the two lobes of the left division of the liver was, though only slightly, the larger; it is the same lobe which is figured as the larger in *Rana esculenta*†. *Megalophrys* agrees with *Rana esculenta* and *R. tigrina* as to the general disposition of the liver-

\* From Borneo. I owe this specimen also to the kindness of Dr. Charles Hose.

† Cf., e.g., 'The Anatomy of the Frog' by Ecker, Engl. trans. by Haslam: Oxford, 1889, p. 295, fig. 194 l.

lobes. The left is very much the larger of the two, and it is subdivided into two lobes of unequal size of which the outer, situated more ventrally, is the larger \*. In *Pelobates fuscus* the right half of the liver is the smaller; the left lobe is also (as in *Megalophrys*) composed of two very distinct lobes of approximately equal size, the inner however being in this case rather the larger. The *pancreas* of both *Megalophrys* and *Pelobates* differs from that of *Rana* as

Text-fig. 99.

Liver and adjacent viscera of *Rana guppyi*.

*g.b.* Gall-bladder. *L.* Liver. *Lu.* Lung. *m.* Mesentery attaching liver to lung &c.

figured by many authors. Its lowest portion is massive in these two genera; but, whereas in *Pelobates* this region of the pancreas is firmly attached to the stomach, it is attached to the duodenum in *Megalophrys*. The separation of the stomach from the duodenum

\* Dumeril & Bibron, 'Erpétologie Générale,' t. viii. p. 456, remark also (of *M. montana*) that the right lobe is but slightly developed and that the left is divided into two.

is more marked in *Megalophrys* than in either *Pelobates* or *Rana*. The pylorus is situated a little way beyond the lowest point of the U formed by the stomach and the duodenum and is marked externally by a raised annular fold.

§ *Ovaries and Oviducts.*

The whole abdominal cavity of this Frog was filled with eggs which were not contained within the oviducts, but in the ovaries themselves. The lobes of the ovary packed tightly with ripe ova, among which were immature ova, were polygonal through mutual

Text-fig. 100.



Oviduct of *Megalophrys nasuta*.

*o.d.* Dilated lower part of oviduct. *ov.* Ovary. *m.* Muscular band attaching ovary to cæcum of oviduct.

pressure. The mesovarium which joins the mesocolon is remarkable for the fact that posteriorly its margin is strengthened by a thick and strong band of muscular fibres. I could not observe any structure of this kind in *Rana guppyi* in the same region. This band of muscles in *Megalophrys* is shown in the accompanying figure (text-fig. 100). It will be there seen that it is broken up into wider and narrower strands of muscle, which are partly con-

tained within or lie upon the mesovarium and thus run towards the median dorsal line of the body, and are partly inserted upon the distal dilated sac in which the oviduct ends (as in *Rana* &c.), and by which it opens into the cloaca.

Traced in the opposite direction, the fibres soon lose themselves upon the ovary. The strand of muscles which is inserted upon the terminal chamber of the oviduct is much the thickest. It was, however, not absolutely accurate to speak of this band of muscular fibres as being inserted upon the dilated posterior chamber of the oviduct. They are really inserted upon a distinct and rather tubular diverticulum of the same, which lies to the inside of the oviduct and naturally points towards the ovary. This diverticulum is certainly totally absent in *Rana guppyi*, where—considering the size of the Frog—it would be easy to detect were it present. The band of muscles continuing on this diverticulum to the ovary associates it particularly with the gonad. The association might be physiological as well as anatomical. For a swelling of the ovaries would tend to fall upon the diverticulum of the uterus, possibly thus stimulating its growth and that of the uterus at the time when it is required to be large for the reception of the ova.

On the left side of the body the structure of the various bands of muscle and the diverticulum of the uterus was not absolutely identical. In fact, there was no appearance of a stout band of muscle applied to the diverticulum of the uterus, only fine fibres in the mesovarium. Nor was the diverticulum so conspicuously marked as on the right side. The two uteri join just before they open into the cloaca on a marked papilla by a single orifice, as in some genera.

The internal orifice of the oviduct in this Frog has a position which differs rather from that of the oviducal aperture of *Rana guppyi*. In the latter it is distinctly to the outside of the lung; in my species it is situated as distinctly to the inside of the lung base. In both cases this funnel-shaped expansion lies upon the ligament attaching the liver to the anterior wall of the abdominal cavity.

#### § Summary of Principal New Facts.

It will be convenient to briefly summarise the chief new facts contained in the preceding pages. They are as follows :—

(1) The genera of the family Pelobatidæ should perhaps be increased by the addition of one for a Bornean species, possibly identical with *Megalophrys nusuta* (auct.), which differs from all other genera of that family in certain features.

(2) This species agrees with *Pelobates* (? as to other Pelobatidæ) and differs from *Rana*, *Ceratophrys*, and some other genera, in the great extent of the visceral layer of the transversalis muscle ("diaphragm"), which is attached along a greater length of the pharynx and arises from the transverse processes of several vertebæ and from the ilium for a long way down, covering over and

completely concealing the ilio-lumbaris muscle, which is entirely exposed in the other genera mentioned.

(3) The equivalent muscle of *Ceratophrys*, though arising as in *Rana* and other genera from the transverse process of the fourth vertebra only, is specialised into three separate slips, supplying respectively the pharynx, lung, and cervical aponeurosis. This specialisation of the muscle is also to be seen in *Rhachophorus* and *Rana guppyi*.

(4) In *Megalophrys nasuta* the sacral vertebra is single and fused with the coccyx and the vertebrae are procelous.

(5) The hyoid in this Frog agrees with that of the Pelobatidae generally in the deficient development of the anterior cornua. These are only represented by a ligament, and the hyoid as a whole most closely resembles that of *Xenophrys monticola* as figured by W. K. Parker. The musculature of the hyoid does not materially differ from that of *Rana*.

(6) The musculature of the back shows characteristic differences among different genera of Batrachians. The genera of Ranidae and Cystignathidae and Bufonidae examined show fewer differences among themselves than any of them do from the Pelobatidae, *Pelobates* and *Megalophrys nasuta*.

(7) In the last two is a peculiar muscle apparently belonging to the ilio-lumbar complex, running from the middle of the ilium directly to the transverse process of the second vertebra, which may perhaps be the equivalent of the "Musculus pulmonum proprius" of *Pipa*. Other comparisons between the muscular system of *Megalophrys nasuta* are remarked upon in the present paper; and other authors have commented upon likenesses between the Aglossa and the Pelobatidae.

#### 4. Contributions to the Osteology of Birds.—Part IX. *Tyranni*; *Hirundines*; *Muscicapae*, *Lani*i, and *Gymnorhines*. By W. P. PYCRAFT, F.Z.S., A.L.S., &c.

[Received March 18, 1907.]

(Text-figures 101–104.)

##### CONTENTS.

- |   |   |
|---|---|
| i. Introductory Remarks, p. 352.            | vi. The Pelvic Girdle, p. 369.                              |
| ii. The Skull of the Adult, p. 353.         | vii. The Pectoral Limb, p. 370.                             |
| iii. The Vertebral Column, p. 366.          | viii. The Pelvic Limb, p. 371.                              |
| iv. The Ribs, p. 367.                       | ix. Summary, p. 372.  |
| v. The Sternum and Shoulder-Girdle, p. 367. | x. Key to the Osteological Characters of the Skull, p. 378. |

##### i. INTRODUCTORY REMARKS.

Although it cannot be claimed for the following pages that they contain a complete account of the osteology of the several groups enumerated above, they may at least be said to contain

the most exhaustive account that has yet been written. Anything like completion will be impossible for very many years to come, owing, largely, to the difficulty in obtaining material. Large as is the British Museum collection of skeletons of these birds, there are considerable gaps to fill.

As a contribution towards our knowledge of the Passeres this paper will, I trust, prove useful. I have endeavoured especially to throw light on the perplexing questions of classification, but with what measure of success time must prove.

## ii. THE SKULL OF THE ADULT.

### *The Occipital Region.*

The plane of the occipital foramen is tilted backwards, owing to the relatively large size of the brain-case, so as to lie almost horizontally: that is to say, almost in a line with the long axis of the skull.

The supraforaminal ridge is not very well marked, in so far as its extension laterad of the foramen is concerned. It generally terminates on the bulla which forms the outer wall of the posterior tympanic recess.

A pair of small foramina may be mentioned here which admit branches of the *vena occipitalis*. In *Pitta*, *Phytotoma*, *Pitangus*, *Tyrannus*, *Prionops*, *Euryceros*, and *Lanius*, for example, these foramina will be found forming the termination of a pair of well-marked grooves traversing the supraoccipital immediately above the occipital foramen; and extending upwards towards the middle line to pass into the foramina in question on either side of the occipital crest. But in *Artamia*, *Artamus*, *Corvinella*, and *Tylas*, for instance, these foramina seem to have shifted, inasmuch as they appear much lower down—immediately above the rim of the occipital foramen; while in *Gymnorhina*, *Pityriasis*, *Dicrurus*, and *Vireolanus* they are found on the free edge of the rim itself.

A cerebellar dome is nowhere very well developed: it is practically absent except among the Tyrannidæ and Artamidæ.

The lambdoidal ridge is generally moderately well developed; though in no case is it so strongly marked as in *Pitta* among the Tyranni, and in *Lalage* and *Graucalus* representing the Campophagidæ; it forms, however, only a very inconspicuous feature of this region of the skull.

*The Cranial Roof* (text-fig. 101).—Save only in the Tyrannidæ, the cerebral dome is broad and well-rounded, while the contour of the cerebrum is plainly indicated, and the interorbital region of the frontal is wide. In this last character it would seem that the Campophagidæ, Prionopidæ, and Laniinæ differ, in that this region is narrow. *Paradisæa* is peculiar in having a relatively long and narrow cranium, but with the cerebral dome well marked. In the Tyrannidæ the cerebral dome is conspicuously depressed, but wide; the interorbital region is generally wide in



this family, but in a few genera the reverse is the case, e. g. *Myiarchus arundinicola*.

No members of the groups here dealt with have developed a true nasal-hinge, but this is feebly represented among certain Tyrannidae, e. g. *Megarkhynchus*, *Rhynchocyclus*, and *Contopus*.

### *The Base of the Skull.*

Basipterygoid processes are not even represented by vestiges. The basitemporal plate exhibits the usual triangular form, the base of which is bounded by a more or less well-marked precondylar fossa; while its two sides have fused, for the greater part of their length from the base forwards, with the ossified connective tissue forming the anterior wall of the recessus tympanicus anterior—converting the Eustachian grooves into tubes opening at the apex of the triangle. The posterior angles of this plate contribute to form the inferior margin of the tympanic recess. Although this plate presents certain differences, when a large number of genera belonging to different families are examined, these differences are of too subtle a character to be of any use for systematic purposes.

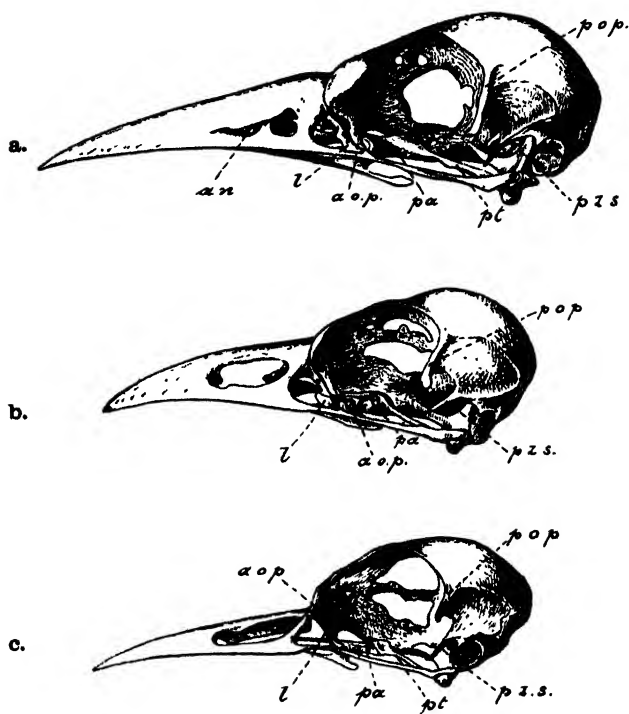
### *The Lateral Aspect of the Cranium.*

The *tympanic cavity*, as seen in the dried skull, may be described as moderately well developed. In some cases, however, a much more spacious cavity is formed by the extension of the lateral wing of the exoccipital. As a rule, this aperture is oval in shape, but in some cases, e. g. *Phytoloma*, *Vireolanus*, *Lalage*, and *Prionops*, it forms a vertical slit, the distance from the shaft of the quadrate in front to the lateral exoccipital wing behind being much less than the height of the aperture, whereas, generally, the vertical axis is but little longer than the horizontal. More rarely the free edge of the lateral exoccipital wing is turned sharply forwards and somewhat inwards, so that a large and nearly closed resonant chamber is formed having a sub-crescentic external aperture, as in *Paradisaea* for example. In the Gymnorhinæ and in *Artamia*, one of the "Vangidæ," the free edge of the lateral occipital wing, instead of sweeping upwards and forwards so as to pass imperceptibly into the *processus articularis squamosi*, is continued upwards till it bisects a ridge running from the squamosal head of the quadrate across the shallow temporal fossa or along its inferior border. This peculiarity will probably be found to obtain in other allied genera, while it occurs also in some *Synallaxis*.

Within this cavity there will be found a strong buttress of bony trabeculae for the inner head of the quadrate, in addition to the usual orifices marking the apertures of the anterior, superior, and posterior tympanic recesses, and the fenestrae rotunda and ovalis. The superior and posterior tympanic recesses, it may be remarked, are relatively small: in *Artamia* they can hardly be traced while in *Laniarius*, for example, they attain their maximum

development. Opening immediately above the squamosal and otic articular surfaces for the quadrate, the latter leads upwards into a chamber filled with cancellated tissue.

Text-fig. 101.



Lateral aspects of the skulls of:—

a. *Gymnorhina organicum*. b. *Laniarius poliocephalus*. c. *Sayornis cinerea*.

a.n. = anterior nares; a.o.p. = antorbital process; l. = lachrymal; pa. = palatine; p.o.p. = postorbital process; pt. = pterygoid; p.z.s. = processus zygomaticus squamosi.

The *Postorbital Region* presents one or two noteworthy characters. The Pittidæ alone develop extensive, but shallow temporal fossæ, which are separated one from the other, in the middle line, only by a median sagittal ridge. In the Tyrannidæ and in the Phytotomidæ this fossa is, though narrower, relatively deeper than in the Pittidæ; but it is confined entirely to the lateral aspect of the cranium, extending backwards, roughly, as far as a point midway between the free edge of the tympanic cavity and the centre of the lambdoidal ridge: the distance varying in different genera. In the remaining Families dealt

with in this paper, the temporal fossa terminates immediately above the tympanic cavity: excepting the *Muscicapidæ*, where it is either extremely reduced or absent.

The postorbital process is obsolete in *Phytotoma*—another of several features which this Family shares with the *Pittidæ*. In the *Tyrannidæ* it is only very feebly developed; and the same is true of the *Hirundinidæ*, *Muscicapidæ*, *Campophagidæ*, and the *Laniinæ* at least among the *Laniidæ*.


The reduction of this process is due to specialisation: and in the forms here dealt with, it has been accompanied by an equally gradual reduction of the "temporal fossa." In all these cases, the process has travelled downwards, nearer and nearer to the *processus zygomaticus squamosi*, and this is nowhere better shown than in a comparison of the skulls of *Muscicapa* and *Terpsiphone* for example; since in the latter the two processes are almost confluent, and further, by the obliteration of the "temporal fossa" the superior margin of the tympanic cavity has extended forwards to join the postorbital process. In the *Muscicapidæ* this margin has crept forwards no farther than the hinder border of the remnant of the fossa. In the *Laniinæ*, the reduction of the postorbital process has been accompanied by a corresponding increase in the size of the *processus zygomaticus squamosi*, which has, in consonance with the use of the jaws for tearing prey, shifted forwards so as to lie midway between the squamosal articular surface of the quadrate and the postorbital process.

Among the Laniiform-types, the *Gymnorhidæ* and *Malaconotidæ* have the postorbital processes of large size, and so also have the *Dicruridæ*, *Eurycerotidæ*, *Artamidæ*, *Vangidæ*, and *Prionopidæ*. The *Gymnorhidæ*, *Artamidæ*, and *Vangidæ*, by the way, are peculiar in that the zygomatic process of the squamosal is bifurcate: or, in other words, mesiad, and a little in advance, of the normal process, there is found a second though slighter peg. So far I have not met with this in any other families.

The orbits present no very important characters in this connection. Only in the *Gymnorhidæ* and *Vangidæ*, it would seem, is the orbito-sphenoid ossified, or the interorbital septum perforated by but a single small fenestra. All the remaining genera herein dealt with have the orbito-sphenoid but slightly, if at all ossified, and the interorbital septum pierced, either by a long narrow upper slit and a wider, inferior fenestra, or by one large fenestra absorbing almost the whole septum as in *Paradisæa*.

*The Ethmoidal Region.*—With that portion of the mesethmoid which takes part in the formation of the interorbital septum I have just dealt. The lateral mesethmoidal wings of the antorbital plates—called by some pre-frontals—which bound the orbit anteriorly, present but few features of special note. *Gymnorhina* is somewhat remarkable in this respect inasmuch as these plates extend outwards and upwards, one on either side, to form a pair of wings of considerable size, and projecting laterally on either side of the nasals, thus greatly increasing the depth of the orbital chamber.

The *lachrymal*, which is attached, as a rule, to the outer margin of the antorbital plate, demands some notice. Unfortunately, in a very large proportion of prepared skeletons of birds this is absent, often because of its reduced size which causes it to be overlooked by the macerator. And thus it becomes impossible to say, when this ossicle is missing, whether it has been lost during maceration or suppressed. That suppression has taken place in not a few instances is almost certain, inasmuch as in skeletons in this collection it may be found reduced to the vanishing point.

In the Families which form the subject of this paper, the lachrymal is least reduced in *Graucalus* among the *Campophagidæ*, and in *Laniarius* among the *Laniidæ*. In *Graucalus* it is roughly -shaped, and attached to the anterior face of the antorbital plate; the free ends of this horseshoe curve are directed outwards, the lower limb projecting beyond the outer border of the plate, and resting on the quadrato-jugal bar. It is formed of highly pneumatic bony tissue and has a conspicuously inflated appearance. In *Laniarius* this ossicle is almost rod-shaped, and has its inferior, free end twisted outwards, considerably swollen, and resting on the quadrato-jugal bar. The main shaft is attached to the anterior face of the antorbital plate, while its upper end is wedged in between the nasal bone and the antorbital plate. *Gymnorhina* agrees very nearly with *Laniarius* in this respect, differing chiefly in that the inferior end of the ossicle rests in a facet on the quadrato-jugal bar. In *Artamus* and *Artamia* it is greatly reduced--in the former, for example, being represented only by a very delicate rod, with a cordiform inferior extremity which does not reach the quadrato-jugal bar, but which projects slightly beyond the level of the antorbital plate. *Prionops* in this matter resembles *Artamus*, except that the rod is somewhat thicker and not markedly inflated at its inferior end. In *Euryceros* it has the form of a sigmoidally curved rod attached to the face of the antorbital plate, as in the preceding cases, and extending downwards to articulate with a tumid prominence on the quadrato-jugal bar. In the *Tyrannidæ* it is attached, not to the anterior face, but to the outer, free edge of the antorbital plate, and extends upwards to the level of the nasal, and downwards to the quadrato-jugal bar. In shape it may be described as spatulate, the blade being flattened along its mesial border where it comes into contact with the antorbital plate; while the handle has a strong outward curvature. Finally, in *Phytotoma* all that is left of this ossicle is a minute spicule attached to the outer edge of the antorbital plate. In no case is an orbital process developed; and only in *Laniarius* is the shaft perforated by a conspicuous pneumatic foramen.

The ossification of the nasal septum and of the walls of the olfactory chamber gives this region of the skull, in the groups now under consideration, an unusual importance.

In the *Tyrannidæ*, this septum, in its simplest form, as in *Pitangus*, extends from the cranio-facial fissure to the anterior end of the narial orifice, and has a knife-like free edge dividing

the anterior palatal vacuity into right and left moieties. The dorsal expanded plate, which gives the usual T-shaped form to the mesethmoid, is here continued outwards and downwards in the form of a small quadrate plate of bone depending from the mesial border of the posterior region of the narial orifice. In *Sayornis*, this ossification of the dorsal mesethmoidal plate extends the whole way along the nasal process of the premaxilla instead of being confined to a small area of the nasal orifice, but the lateral extension of the plate so formed is not great, and is most noticeable near the middle of the orifice. The median, vertical region of the septum has its free edge expanded to form a narrow plate, grooved along its inferior surface down the middle line, and extending nearly the whole length of the anterior palatal vacuity, the hinder end of the plate being forked. And this obtains also in *Contopus*, *Tæniopterus*, and *Rhyncocyclus*—and doubtless in many other genera.

The Muscicapidæ have a nasal septum agreeing in all respects with that described as obtaining in *Contopus* and *Sayornis* for example. In the Campophagidæ, however, this septum is either altogether absent, in the dried skin, or is represented only by a feebly ossified ridge running down the inferior aspect of the nasal process of the premaxilla.

Among the Laniidæ, as the group stands in Dr. Sharpe's 'Hand-list' (8), the *Laniine* agree with the Tyrannidæ and Muscicapidæ in having the inferior border of the nasal septum expanded by lateral flanges, but these are, in the group now under discussion, very narrow.

In *Sphecotheres*—which genus will be discussed in detail later (p. 376)—the nasal septum is of this type. And the same is true of the Prionopidæ. In this family, however, secondary ossification of the cartilaginous outer wall of the nasal capsule conceals the septum from the inferior aspect of the skull. At first sight, however, the existence of this floor beneath the septum would not be suspected; but rather it would be regarded as the septum itself, which had developed unusually wide flanges, since it has all the appearances of a septum such as occurs in the Tyrannidæ, differing therefrom, mainly, in being fused anteriorly with the premaxillary palatal plate.

In the Phytotomidæ, and in *Corvinella*\*, Artamidæ, and the Gymnorhinæ among the Laniiform types, the wall of the vestibulum is ossified; and this in such a way that the postero-superior angle of the normal narial aperture is cut off to form a slit-like aperture, bounded mesially by the vestibular wall, and externally by the descending process of the nasal. Traced backwards this slit leads into the lachrymo-nasal fossa, and thence into the choanæ.

The restricted narial aperture is small, and circular, owing to the ossification of the cartilaginous nasal capsule—the vestibulum. It leads into a chamber, small in *Artamia*, large in *Artamus* containing a well-developed *concha media*. This turbinal in

\* *Lanius excubitor* agrees with *Corvinella* in this respect and differs from the remaining members of the genus.

*Artamia* is scroll-shaped, and attached to the floor of the chamber and to the horn of the bifurcate vomer.

In *Artamus* the chamber is much larger, and, as in *Artamia*, is open behind. The septum nasi is perforate, placing the right and left chambers in communication, in the dried skull. The *concha media* is large, conch-shaped, and attached by its posterior end, caudad of the tip of the vomer, to the extreme hinder end of the vertical outer wall of the vestibule; so that this turbinal lies above the vomer, and is bounded mesially—at its posterior end—by an upward, vertical, flange developed by the palatine. *Corvinella* resembles *Artamia* in this matter; and the same is true of *Gymnorhina*, but the *concha media* of each side is here attached to the tips of the bifurcate vomer, while its wall is cribriform.

The floor of the olfactory chamber, in the forms now under discussion, demands a more detailed notice than is usually the case with this region of the skull.

In all save the Artamidæ, Prionopidæ, and Gymnorhidæ, this floor is cartilaginous, so that, in the dried skull, there is a large palatal foramen which is divided by a median partition—the *septum nasi*. This, generally, has its free edge broadened by a flange along each side, thereby reducing the size of the foramen. In the exceptional cases this floor becomes completed by the ossification of the nasal capsule in connection with the septum, converting the palate into one of the desmognathous type. That this desmognathism is caused by the ossification and fusion of the inturred capsular wall of the vestibule with the inferior border of the nasal septum, and not by the fusion of the maxillo-palatines with the septum, is clear from a study of the palate of say *Vireolanus* (text-fig. 102 e, p. 362), where this ossified capsule extends backwards above the maxillo-palatines, or of the Prionopidæ (e. g. *Prionops*), where a narrow chink is left on each side of the septum immediately in front of the vomer. In *Paradisæa* the septum descends as it were, so as to close up a median chink, left between the right and left portions of the vestibular floor, while both floor and septum are sharply truncated posteriorly, so as to impinge on the maxillo-palatine process and the vomer (text-fig. 103 b). In the Gymnorhidæ the vestibular floor meets beneath the nasal septum, but it has not blended with the palatal surface of the premaxilla, which presents a sharply defined posterior border into which the ends of the palatines are thrust.

#### *The Premaxilla and Nasal.*

These bones present no characteristics sufficiently remarkable to dwell upon here. Suffice it to say, that the palatal surface of the premaxilla is often apparently increased by fusion with the ossified nasal capsule, while the nasals are always holorhinal; and in some cases, as has already been pointed out, the form of the nasal aperture has been altered by a similar ossification of this capsule.

In the Pittidæ and in *Terpsiphone* among the Muscicapæ there is a fairly well-developed nasal hinge.

*The Maxillo-jugal Arch.*

The *maxilla*, in the skulls now under analysis, presents features of unusual interest, inasmuch as this element of the jaw retains more primitive characters than are to be met with among the remaining Oscinine Passeres. My examination of this bone must begin with the Tyrannidæ. Though in the adult the extent of the maxilla cannot be determined, the palatine process thereof forms a large triangular plate with its apex curved backwards in a semi-circle, almost meeting the free, anterior, end of the vertical descending, scroll-shaped plate of the palatine (text-fig. 102 b, *mx.p.*) and underlying the free end of the vomer.

In the Pittidæ this maxillo-palatine plate has perhaps preserved even more of its original shape, since it is larger and less pointed at its apex (fig. 102 d, *mx.p.*).

The Muscicapidæ present the early stages of transition which eventually produced the type of maxillo-palatines met with in the higher Passeres. In *Newtonia* these processes are broad, strap-shaped, and deeply pitted below by a pneumatic foramen, while their direction is backwards. In *Terpsiphone* the maxillo-palatine processes are long and narrow, and spring from a broad shelf of bone which passes forwards into the palatine process of the pre-maxilla; and the same is true of *Piezorhynchus*. In *Muscicapa* the final stage is reached: the maxillo-palatine being reduced to a long, slender, curved bar springing from a rod-like base. The free end of the process almost touches the free end of the descending vertical scroll of the ventral aspect of the palatine.

The Campophagidæ closely resemble the Muscicapidæ in the form of the maxillo-palatine process; it appears to differ chiefly in that it is relatively shorter than in the Muscicapidæ.

Among the Laniidæ, as at present constituted, this region of the palate presents two strongly contrasted phases of development. In the less specialised Laniinæ, e. g. *Lanius*, *Laniarius*, and *Dryoscopus*, the maxillo-palatines do not differ essentially from these elements in the Campophagidæ, a large palatal vacuity bounding these processes in front. But in *Corvinella* the anterior palatal vacuity is partly filled up by the ossification of the vestibular floor. The Prionopidæ and the Dicruridæ agree with *Corvinella* in this respect. The Gymnorhinæ, included by Dr. Sharpe with the Laniidæ, differ markedly from the Laniinæ in this matter; and this on account of the ossification of the vestibular wall and nasal septum already referred to (p. 358).

In *Pityriasis* and *Gymnorhina* the anterior palatal vacuity is closed, in part by the ossified floor of the vestibulum, and in part by the nasal septum, so that only a small pit is left in front of the vomer. The Artamidæ and Vangidæ in this matter agree with the Gymnorhinæ. The palate of the aberrant *Erocharis* (*Euryceros*) in many respects recalls that of the Gymnorhinæ (p. 359) and Artamidæ, but it differs in that the maxillo-palatines in front of the maxillo-palatine processes are inflated, forming a

mass of cancellated tissue, surrounded, above and below, by a large air-sinus, so that a considerable space is left, in the dried skull, between the ossified floor of the vestibulum to which the palatines are attached and this cancellated mass.

The quadrato-jugal bar affords no characters requiring comment.

### *The Vomer, Pterygoid, and Palatine.*

The *vomer* is of the typically Passerine type, but presents certain features worthy of note. Broad, and of moderate length, its ventral aspect, in the simpler forms, e. g. *Tyrannus*, is that of an oblong plate of bone cleft in the middle line from behind forwards for rather more than half its length, and sharply truncated in front. The right and left posterior limbs pass insensibly into the palatines. Anteriorly, the vomer expands to form a pair of thickened quadrangular horns the external, lateral faces of which lodge a more or less cup-shaped depression.

The Tyrannidæ and Muscicapidæ agree very closely in the form of the vomer. The Campophagidæ, however, would appear to be even simpler in this respect than either of these two Families, inasmuch as in *Campophaga* the vomer is anteriorly sharply truncated and lacks the quadrangular anterior horns, though an approximation to these is to be seen in the vomer of *Tylas*.

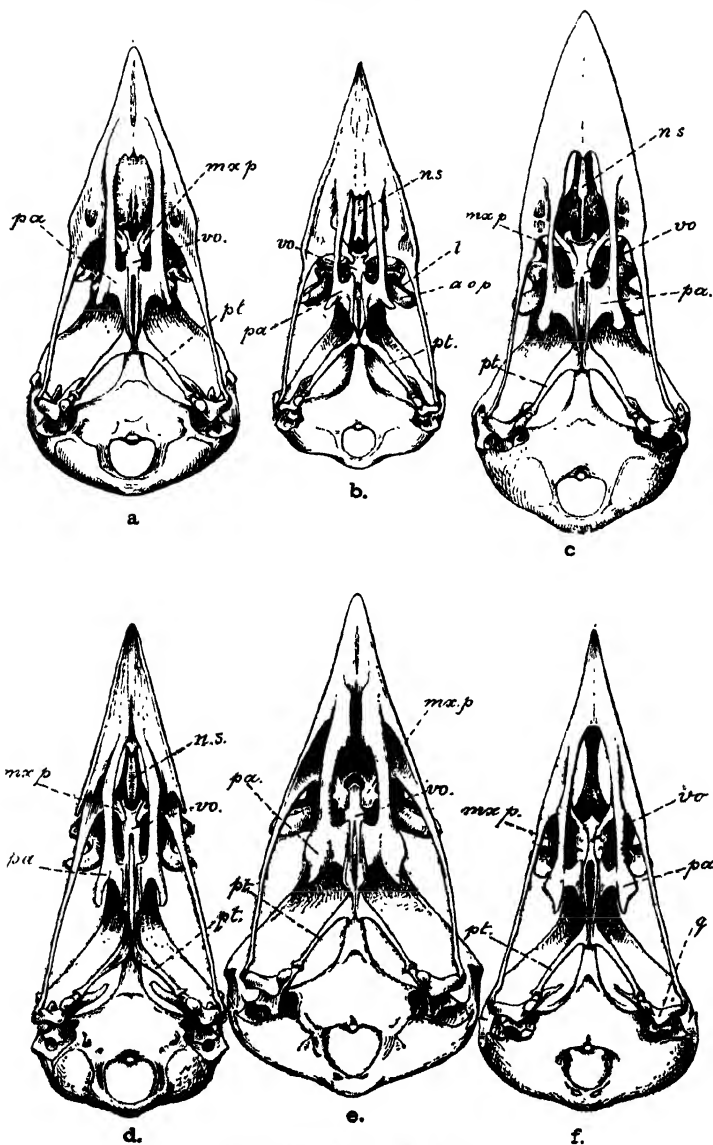
In the Laniinæ the vomer, as in the Tyrannidæ, expands, anteriorly, into a pair of quadrangular horns, but each sends backwards from its antero-dorsal angle a thin plate of bone which, running backwards along the outer margin of each side of the dorsal aspect, gives the vomer, when seen from above, a trough-shape. Further, in *Laniarius*, the quadrangular horns referred to afford, on either side, an articular surface for the maxillo-palatine process.

The Dicuridæ differ from the typical Laniidæ in the form of the vomer chiefly in that in the former it is relatively broader, especially at its anterior end which is sharply truncated. The increased width, anteriorly, is due to the fact that the "horns" project outwards and forwards instead of directly forwards. These horns, furthermore, are peculiar in that they send downwards a broad facet to articulate with the spatulate maxillo-palatine process. The terminal "horns" of the vomer rise upwards to embrace the free edge of the nasal septum, and are continued backwards along each side of the dorsal aspect of the vomer, thereby converting this into a shallow trough.

In the Gymnorhinæ the vomer is more conspicuously modified than in any other of the types herein discussed; being short, antero-posteriorly, and having a well-defined median ventral keel and deeply trough-shaped dorsal aspect. These characters are perhaps most marked in *Gymnorhina*, though in *Pityriasis* they are scarcely less so. In the former genus the free end (anterior) of the vomer is deeply cleft, while the under surfaces of the two resultant horns are cut away, or hollowed out, so as to



Text-fig. 102.



Ventral aspects of the skulls of:—

a. *Artamus leucogaster*.

b. *Sayornis cineracea*.

c. *Terpsiphone*.

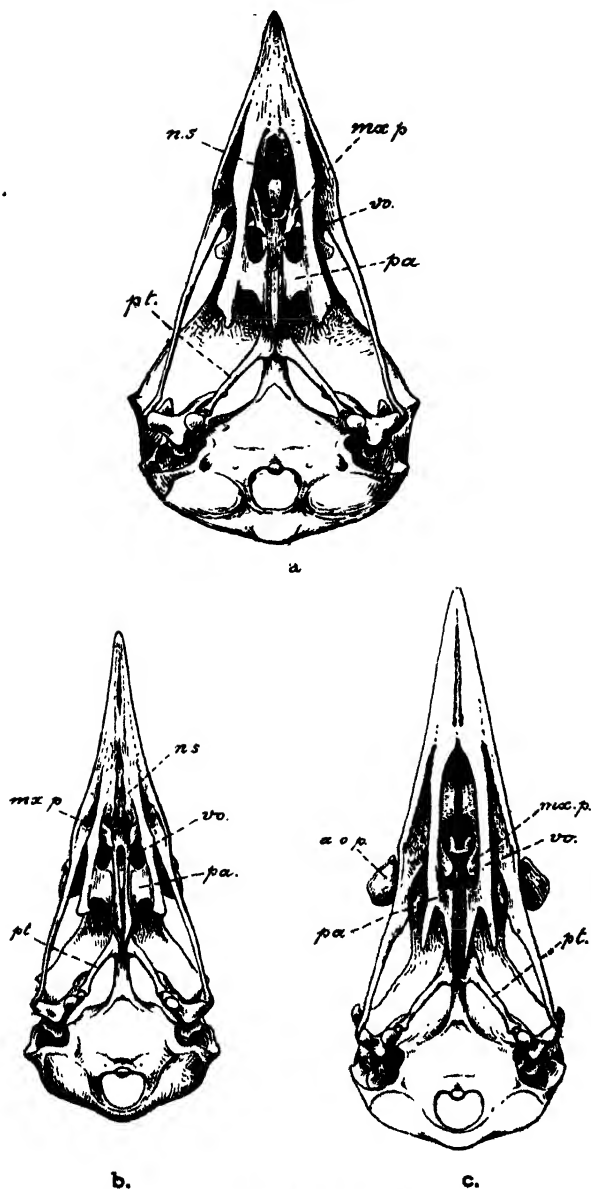
d. *Pitta hardi*.

e. *Vireolanius leucotis*.

f. *Vireo olivacea*.

a.o.p. = antorbital process; mx.p. = maxillo-palatine process; ns. = nasal septum;  
pa. = palatine; pt. = pterygoid; q. = quadrate; vo. = vomer.

Text-fig. 103.



Ventral aspects of the skulls of:—

a. *Lanius collurio*. b. *Paradisaea raggiana*. c. *Gymnorhina organicum*.

Letters as in text-figs. 101, 102.

stand out in sharp contrast with the ventral median keel of the body. The horns rise directly upwards for a considerable distance, and being continued backwards along each side of the dorsal aspect, this region is converted into a deep triangle.

It is to be noted that in the matter of the vomer and its relation to the maxillo-palatines, the skull of *Euryceros* very nearly approaches the *Gymnorhinæ*. This is a fact which greatly assists in the difficult task of deciding the true position of this bird in the system. It is further noteworthy that the peculiarly inflated condition of the maxillo-palatines in the pre-maxillary region may well have been derived from conditions such as obtain in the *Gymnorhinæ*.

The *pterygoid* throughout this series is elongated, and round or triangular in section. Basipterygoid processes being absent, this rod extends directly from the quadrate to the palatine, and parasphenoidal rostrum. Consequently the principal feature of interest for description here concerns the nature of the palato-pterygoid articulation. Before entering on this subject, however, it may be remarked that the triangular flange which, in the higher Passeres, *e. g.* Corvidæ, extends from the rim of the dorsal segment of the cotylus for the quadrate, backwards along the shaft, is in the forms herein described represented by a slender style, forming a V-shaped angle with the shaft of the quadrate, *e. g.* *Sayornis*. In many cases, however, it is reduced to a mere tubercle, or it may even be absent.

As touching the nature of the pterygo-palatine articulation. This takes two forms. Generally, the pterygoid terminates distally in a leaf-shaped plate, the inner surface of which is applied to the parasphenoidal rostrum, while the inferior edge thereof glides over the edge of the obliquely truncated proximal end of the palatine. This method of articulation has been derived, as I have elsewhere pointed out (6), from an earlier condition of things wherein the pterygoid extended forward to support the vomer. By segmentation of the pterygoid, and the fusion of the vomerine portion with the palatine, the characteristic palato-pterygoid joint has been formed. In a number of cases, however, a pseudo-primitive condition obtains: the pterygoid, instead of segmenting, preserves its integrity, and fuses with the palatine, *e. g.* *Dicruridæ*, *Prionopidæ*, *Laniinæ*, *Gymnorhinæ*, *Malaconotidæ*, *Artamidæ*, and *Vangidæ*. This fusion of the pterygoid and palatine I have already shown (5) obtains also in the *Eurylemidæ* and the *Tracheophone Passeres*.

The palatine, distad, has the form of a straight rod which is continued backwards considerably beyond the level of the antorbital plate, terminating in a more or less sharp point. Immediately below the inferior border of the antorbital plate it sends inwards, almost at right angles, a broad bar which gives rise to a long trough-shaped scroll running parallel with the long axis of the skull, and with its concavity turned towards the middle line. The upper edge of the scroll affords support to the vomer and pterygoid, while the inferior margin is free, and with its fellow of

the opposite side forms a long tubular cavity, open below, and roofed above for the most part by the vomer.

In my earlier papers on the Eurylæmidæ and Tracheophone Passeres (5) I have described the upper lamina of this scroll as affording a surface to facilitate gliding along the parasphenoidal rostrum. As a matter of fact, this is not really the case: the palatine hardly touches the rostrum, which is embraced only by the distally expanded ends of the pterygoid.

The free end of the palatine rod—caudad of the bar which connects this with the body of the bone—is conspicuously long and spike-like in many Tyrannidæ, the Vangidæ, and Artamidæ (if these two can be regarded as distinct families) and Gymnorhinæ. This spur is referred by W. K. Parker to the “transpalatine,” but it is doubtful whether this homology exists.

The quadrate presents no very striking characteristics. It differs from that of the Eurylæmidæ and the Tracheophone Passeres in that, except in the Phytotomidæ, the quadrato-jugal bar is not set out from the quadrate by a cylindrical boss of bone laterad of the outer articular condyle. The condyle, however, stands far out, laterad, of the long axis of the quadrate. The internal mandibular condyle of the quadrate is, in the Phytotomidæ, conspicuous for its large size and spherical shape. The squamosal and otic heads are well marked; and the orbital process is conspicuous for its great length, terminating in a point, except in the Phytotomidæ wherein the orbital process is greatly reduced.

#### *The Mandible.*

The mandible, like the quadrate, affords no very important features. The lateral vacuity, which is placed far back, is always small. The angular process is always short, especially in the Gymnorhinæ and Vangidæ, and in *Pitangus* among the Tyrannidæ. In *Artamus* and *Gymnorhina* the mandible is truncated posteriorly. The internal angular process is of moderate length, though in *Pityriasis* and *Artamia* it must be described as very short.

#### *The Hyoid.*

Unfortunately in only three skeletons of the whole series examined during the preparation of this paper are the hyoid bones preserved. At the time when these skeletons were made no great care was taken to preserve these bones. As these hyoids belong to very different forms and have not hitherto apparently been recorded, we may briefly indicate their structure.

The Dicruridæ are represented in this matter by *Edolius forficatus*. Herein basi-hyals are represented by a pair of rod-shaped bones lying side by side, and terminating, posteriorly, in a free spine. Basi-branchials 1-2 are fused, and both agree in being much elongated. The cerato-branchials are of moderate length; the epi-branchials are unfortunately missing.

In *Newtonia* the basi-hyals are relatively longer, narrower, and enclose a space between them. Basi-branchial 1 is shorter than 2,

which is relatively somewhat longer than in *Edolius*. The cerato- and epi-branchials are of moderate length.

In *Myiarchus* the basi-hyal is wanting; cerato-hyal 1 is short while 2 is relatively longer than in the species just described. The cerato-branchials are extremely long; the epi-branchials unfortunately are missing.

### iii. THE VERTEBRAL COLUMN.

The presynsacral vertebræ are all heterocœlous and free.

As to the general characters of these vertebræ there is but little that can be said to any purpose. The odontoid ligament is ossified throughout; hypapophyses occur on the 2-4 cervicals, and extend from the eleventh cervical to the first thoracic.

The composition of the column, however, furnishes one or two interesting points.

First, as to the cervical and thoracic regions. The last thoracic vertebra has passed into the synsacrum, but, ignoring this fact for the present, we may remark that the total number of vertebræ in these two series ranges from 19 to 21.

The last cervical bears a pair of long free-ribs, but without uncinæ, or sternal segments. As a rule there are but six thoracic vertebræ bearing long ribs, and of these vertebræ the last is fused with the synsacrum, while its ribs just fail to reach the sternum. *Sayornis* among the Tyrannidæ, however, has seven thoracics. The sternal segments of the 6th pair are attached to the sternal segment 5, some distance above the sternum, while the similar segments of the 7th pair are attached to small facets, one on each rib, high up on the sternal facet of the 6th. Of the seven thoracics in *Artamus* the ribs of the 6th pair reach the sternum, articulating therewith immediately behind the 5th pair by a much reduced joint. The ribs of the 7th pair of vertebræ are represented only by a pair of rods, almost hair-like in delicacy, attached to the tip of the thoracic, and the upper third of the sternal segment of the 6th ribs.

The number of synsacral vertebræ ranges between 16 and 19; the number of free caudals between 6 and 8. In no case have both the sacrals preserved ribs, and only rarely can traces of the ribs of the 2nd sacral be found. The chief numerical differences may be stated as follows:—

	TYRANNIDÆ.		MUSCICAPIDÆ.
	<i>Sayornis.</i>	<i>Tyrannus.</i>	<i>Terpsiphone.</i>
Thoracic .....	1	1	1
Lumbar .....	2	3	3
Lumbo-sacral ...	1	2	1
Sacral .....	2	2	2
Caudal .....	3+7 free caudal	4+7	4+7
	<hr/> 9	<hr/> 12	<hr/> 11
	<hr/> Total 16.	<hr/> Total 19.	<hr/> Total 18.

	DICRURIDÆ. <i>Edolus.</i>	GYMNORHINÆ. <i>Pityriasis.</i>
Thoracic .....	1	1
Lumbar .....	3	3
Lumbo-sacral .....	1	2
Sacral .....	2	2
Caudal .....	4 + 6	5 + 6
	<hr/> 11	<hr/> 13
	Total 17.	Total 19.

Compared with the Tracheophone Passeres these numbers are of some interest, inasmuch as they show that the vertebral column of the forms now in question has become more specialised by the reduction in the number of the synsacral and free caudal vertebræ. In the Tracheophonæ the number of these vertebræ is never less than 19, the lumbo-sacralæ are never less than two—generally three are present: as against the single vertebra of many Tyrannidæ, Muscicapidæ, and Dicruridæ.

#### iv. THE RIBS.

The number of the ribs has already been referred to, but a brief reference may be made here to one or two structural peculiarities of interest. In *Pityriasis*, for example, the upper portions of the thoracic segments are conspicuous for their great breadth, as well as for the unusually large size and breadth of the uncinate which are attached to their respective ribs by broad oblong bases. *Buchanga*, one of the Dicruridæ, shows an approach to this condition. Only in *Gymnorhina*, apparently, has the last thoracic rib retained its uncinatæ. It would be interesting to discover whether there is anything in the mode of life of the Gymnorhinæ which could account for the width of the thoracic ribs and uncinate just referred to.

#### v. THE STERNUM AND SHOULDER-GIRDLE.

With the exception of the Pittidæ the sternum is of the typical Passerine type in all the forms herein described, having but a pair of posterior notches and a long Y-shaped *spina externa*. The peculiar sternum of *Pitta* has already been described by me (5). Except that the *corpus sterni* varies in its relative length, the sterna now under consideration afford no appreciable distinguishing characters. Only the Gymnorhinæ and the Paradiseidæ have the sternal plate elongated, and even here this is not a very striking feature.

The coracoid grooves in all cases are deep; and similarly, in all cases, the articular surfaces for the sternal ribs are confined to the anterior lateral processes.

The *carina sterni* is deep in all save the Gymnorhinæ, though

even there it is fairly well developed, except in *Pityriasis* and *Euryceros*, which have a markedly shallow keel.

The posterior notches, though differing slightly among different genera, in the matter of length, do not afford any matter for comment except in the *Paradisidæ*, where, by the expansion of the free end of the posterior lateral process, the notch becomes converted into a foramen. Whether, however, this character obtains throughout the *Paradisidæ* remains to be seen.

The *coracoid* shaft is typically passerine, being long and slender, and having a broad flange extending along the outer border of the shaft from the base forwards nearly as far as the middle; while the *acrocoracoid* is long, turns forwards and inwards, and sends backwards a hook-shaped process affording additional attachment for the *furcula*. The *procoracoid* is obsolete or absent, except in the *Tyrannidæ* and *Phytotomidæ*, where it forms a long, hand-like spur affording a shelf for the articulation of the *scapula*.

The *scapula* affords no matter for special comment except in so far as the *acromion* is concerned. In the *Tyrannidæ* and *Phytotomidæ* this process is not so well developed as in the higher forms herewith associated, inasmuch as it does not send down, into the foramen *triosseum*, between the *clavicle* and the *coracoid*, a spur for the support of the free end of the *furcula*. Instead the posterior border of the pedate expansion of the free end of the *furcula* rides in a trough hollowed out of the anterior face of the *acromion*. In the remaining forms here described this method of articulation also obtains, but the inner wall of the trough is continued downwards to form the spur to which allusion has just been made.

The *furcula* presents a remarkably uniform character throughout this series, varying, to any appreciable extent, only in the form of the expanded free end of each limb. In all, the *hypocleidium* is more or less oblong and directed upwards, so as to present a nearly vertical face towards the anterior border of the *carina sterni*. In the *Tyrannidæ* and *Hirundinidæ* each limb terminates in a roughly spatulate free end the postero-superior angle of which is received into a groove in the *acromion* of the *scapula*. The middle region of the outer surface of this plate is applied to the *acrocoracoid*, thus enclosing the *foramen triosseum*. By way of contrast a comparison should be made with say the *furcula* of *Gymnorhina*. Here the free end is roughly T-shaped, while it articulates with the anterior face of the *acromion* rather than with its end, a relationship which, it may be noted, may be seen in its incipient stages in the *Tracheophonæ*.

The foramen *triosseum*, then, in the *Tyrannidæ* is bounded, without by the *acrocoracoid*, and on the inside by the expanded free end of the *furcula* and the *acromion* of the *scapula*—these two elements articulating by means of two opposed surfaces set transversely to the long axis of the *scapula*. The higher *Passeres* differ only in that the articulation between *scapula* and *furcula*

is by oblique facets, so that the posterior half of the inner wall of the foramen is bounded by a spine-like projection fashioned out of the acromion,—the inner side of the spine forming the articular surface for the furcula.

#### vi. THE PELVIC GIRDLE.

The pelvic girdle presents no very striking modifications, neither does it afford any important structural characters such as can be of use for systematic purposes. But there are nevertheless features which deserve mention.

In the Tyrannidæ the pelvis is broad, the ilia being widely separated by the transverse processes of the synsacrum. The pre-iliac region is moderately long and varies slightly in its shape in different genera. The superior margin of the *fovea iliaca anterior* in all, however, fades away in the region of the antitrochanter and is not continued backwards into the free edge of the dorsal plane. The postacetabular ilia are broad, and twisted horizontally to form a broad dorsal plane, and enclose between them a broad plate formed by the synsacrum and its transverse processes. Ossification however has almost completely obliterated the intertransverse sacral foramina. The ischium is narrow, and has its postero-inferior angle produced backwards into a long style, which, at its tip, serves as a point of attachment to the pubis. This is long and slender, and is produced backwards for some distance beyond the free end of the ischium. The ischio-pubic fissure is wide and long; shut off anteriorly from the obturator foramen by a bony bar, and closed posteriorly by the junction of the ischium with the pubis. The ilio-ischiadic foramen is relatively large. There is no pectineal process. The *fovea lumbalis* is shallow, and the *fovea ischiadica* and *pudendalis* pass almost insensibly into one another.

The pelvis of the smaller forms of the Families now under consideration does not differ materially from that just described as typical of the Tyrannidæ. In larger birds, such as the Gymnorhinæ, the girdle is relatively much longer, while the pre-ilia rise up to the level of the synsacral ridge, nearly meeting one another in the middle line. There is a single row of intertransverse sacral foramina; the ischio-pubic fissure is very wide, and closed posteriorly, but it is not shut off from the obturator foramen by a bony bar.

That the form of the pelvis may be very largely modified by the decline of the power of flight and the consequent increased use of the hind limbs, may be seen in the pelves of such birds as *Euryceros prevostii* and *Newtonia brunneicauda*. Both these species would seem to be relatively poor fliers, inasmuch as the carina sterni is but feebly developed: and this is especially true of *Newtonia brunneicauda*—one of the Muscicapidæ wherein the keel of the sternum is remarkably shallow. Here the width of the pelvis is increased by the lateral extension of its dorsal plane, while greater depth is



gained by the sharp downward turning of the spine-like postero-inferior angle of the ischium which transforms the closed ischio-pubic fissure into a foramen of considerable width.

#### vii. THE PECTORAL LIMB.

Were it possible to examine the wing-skeletons of a large number of genera of any of the Families herein described, data might be found for use in systematic work. So far, however, such a collection is not to be met with in any museum. From the material at my present disposal it is possible to deal only with the main features of the wing, and these do not display any very remarkable characters.

The humerus only is pneumatic, except in the Hirundinidæ, wherein all the wing-bones are non-pneumatic. But this segment of the limb differs, in the several genera, chiefly in the relative development of the deltoid crest, and of the ectepicondylar process: a relation, in so far as the deltoid crest is concerned, which varies as the power of flight. Where this is strong, as in the Hirundinidæ and Gymnorhinæ for example, this crest is of considerable size, having an oval contour, projecting well beyond, and extending down the shaft, for about one-third of its length. Where the flight is weak, as in the Tyrannidæ, this crest is barely developed. Curiously, however, the size of the ectepicondylar process does not appear to depend on the flight to the same extent, since in *Tyrannus*, for instance, it is relatively larger than in *Gymnorhina*. But this appearance is deceptive, and is due to the relatively more slender shaft of *Tyrannus*. Nevertheless the ectepicondylar process does not appear to be so directly under the influence of flight as the deltoid crest. In *Tylas*, for instance (in the 'Hand-list of Birds' placed with the Pycnonotidæ, but probably one of the Prionopidæ, or Dicruridæ), the power of flight, judging from the size of the *carina sterni*, does not seem to have undergone any serious reduction; this process is small, and surmounted by a small, but sharp spike. Similarly, in the Campophagidæ, this process is greatly reduced, but a small spike remaining; and here again full powers of flight are certainly retained. In this reduced size of the ectepicondylar process, these birds resemble the Pittidæ and Eurylæmidæ, so that yet another alternative may be presented—the character may be a primitive one. In the Swallows there is a large entepicondylar process lying behind the ulnar condyle, and projecting directly backwards.

The forearm is relatively long and straight in all, though the radius is slightly broad save for its distal one-third which is straight. The ulna has prominent tubercles for the attachment of the secondary remiges, and a pointed olecranon process, which interlocks with a corresponding entepicondylar spur on the humerus.

The manus is the most variable segment of the limb, inasmuch

as in some forms, as in the Tyrannidæ for example, and in *Newtonia* among the Muscicapidæ, it does not exceed the humerus in length, while in others, as in the Gymnorhinæ, it considerably exceeds the humerus, being as long as, or slightly longer than, the forearm. *Pityriasis*, however, among the Gymnorhinæ is exceptional: all the segments of the wing being short, the forearm especially so; but this, it is to be noted, is associated with a relatively shallow sternal keel. The intermetacarpal plate is well-developed, and as a rule there is a deep groove along the dorsal aspect of Mc. II. for the tendon of the *extensor indicis longius*. This groove is exceptionally deep in *Gymnorhina* and the Hirundinidæ.

In the Swallows indeed the manus has become considerably modified in response to the great strains put upon it. And this is especially noticeable with regard to Ph. 1 of D. II. This phalanx is of great breadth, flattened dorsally, and widest at its distal end: while on its ventral aspect it presents the appearance of an oblong bone deeply hollowed along its centre, and having its preaxial border produced proximad in the form of a tubercle to afford extraligamentary attachment to its metacarpal. Metacarpal III. is produced for a considerable distance beyond Mc. II. and supports a slender phalanx. The terminal phalanx of D. II. (Ph. 2) is very small. In the Hirundinidæ the humerus does not exceed the carpo-metacarpus in length. The pollex is greatly reduced.

Compared with the Eurylæmidæ the wing, in the forms herein described, shows a more specialised condition in the greater development of the deltoid crest and ectepicondylar process of the humerus; and in the broadening of the metacarpals I. & II.

#### viii. THE PELVIC LIMB.

When the skeletons of a sufficiently large number of genera and species have been got together, it will probably be found that the pelvic limb will reveal useful characters for systematic purposes. With the limited material at my disposal however, I can do no more than outline the general characters of this portion of the skeleton.

The femur, which is relatively long and slender, appears to be pneumatic only in *Tylas*, *Newtonia*, *Euryceros*, *Artamia*, and *Artamus*. The popliteal fossa is obsolete. The tibial condyle develops a more or less prominent spur laterad of the slight depression which marks the popliteal depression in *Newtonia*, *Vireolanius*, and *Paradisæa*. As a rule the tibial and fibular condyles are subequal, but in the Gymnorhinæ and the Dicruridæ the tibial condyle is markedly larger.

The tibio-tarsus is long and slender, and slightly inflected at the tip: the intercondylar gorge is deep and wide; while the extensor groove immediately above is traversed by a bony "extensor bridge," which is generally wide. Immediately above the bridge, on the fibular side of the shaft, is a more or less prominent

tubercle, while on the opposite side of the tibial shaft, and some considerable distance above the entocondyle, is a similar condyle, generally much larger. These serve as points of attachment for the *ligamentum transversum*, which keeps in place the tendon of the *tibialis anticus*. The ento- and ectocnemial crests differ considerably in their relative development. Thus in the Tyrannidæ they are but feebly developed; in the Pittidæ the entocnemial is large, the ectocnemial very small; while in the Gymnorhinæ, for example, both are very strongly developed. The size of these crests does not appear to vary in proportion as the wings are less used. But a more careful study of the habits of the different types which present these differences may show that they vary as the legs are used in perching—as in birds haunting thick undergrowth and flying but little—or walking.

The tarso-metatarsus is short in arboreal types, such as the Tyrannidæ, long in those which spend their lives for the most part on the ground, as in the Pittidæ and Gymnorhinæ. In all, the outer border of the shaft is produced backwards into a bladder-like ridge; and in some this is very marked, as in *Gymnorhina* and *Paradisea* for instance. The hypotarsus is complex, and takes the form of a backwardly projecting spur pierced by several foramina.

The trochleæ are, as it were, cut out of the flattened and expanded distal end of the shaft, so that all lie in the same plane. The ento- and mesotrochlea are subequal in length, but the ectotrochlea is slightly shorter, and generally also much smaller: presenting only a narrow rim for the articulation of the digit. Only the mesotrochlea indeed presents the typical grooved articular surface.

The anterior face of the proximal end presents characters which may prove of service. Thus in the Tyrannidæ, for instance, this region is rounded on its outer border, and bears a tubercle for the insertion of the *tibialis anticus*; while below the inner cotylus is a bony bridge—the ossified ligament which guides the tendon of the *extensor longus digitorum*. In the Gymnorhinæ this region of the shaft is deeply hollowed: the extensor bridge is ligamentous, and the shaft is perforated by two small foramina, one on either side of the median digit. The Pittidæ appear to agree with the Tyrannidæ in these particulars, which appear to obtain also throughout the rest of the Families herein described.

#### ix. SUMMARY.

I have ventured, on the evidence chiefly of osteological and myological characters, to associate many Families which have hitherto been separated, often widely. Furthermore I have endeavoured, in the course of this summary, to show that the ranks of these Families must be enlarged to receive forms which till now have been regarded as having no affinities therewith.

It will be remarked that I have included in this paper the

Families Phytotomidæ, Pittidæ, and Tyrannidæ. This I have done because there seems good reason to regard these three nearly related Families as close allies of the Diacromyodean Passeres.

As Fürbringer—improving on the earlier work of Huxley (2), Sclater (7), and Newton (3)—has already suggested, the Passeriformes should, I think, be regarded as forming four Suborders:—

- 1 Eurylæmi.
- 2 Oligomyodi.
- 3 Tracheophones.
- 4 Diacromyodi = Oscines.

With the Eurylæmi must be included the Eurylæmidæ, Cotingidæ, Pipridæ, and Philepittidæ: the whole forming one of four great branches of a common stem. The other three give rise, respectively, to the Tracheophonæ, the Tyrannine forms (including the Phytotomidæ and Pittidæ), and the Diacromyodean Passeres.

The Phytotomidæ, I would remark, are certainly more nearly related to the Tyrannidæ than to the Pittidæ; and this fact is largely borne out by the structure of the skull.

Osteologically, the Oligomyodean and Diacromyodean suborders have much in common. The skeletons of the Tyrannidæ and of the Muscicapidæ, for instance, present very close resemblances.

The formation of the Suborders just referred to is based largely on myological characters, such as are afforded by the syrinx and the wing-muscles. All that concerns the former is so well known that it will not be necessary to repeat it here. As to the wing-muscles, however, a few words are necessary.

In earlier papers (5) I have already shown that the *deltoides major* (*pars longa* and *pars brevis*) affords useful characters for systematic purposes; and the condition of these muscles in the groups now under discussion offers further confirmatory evidence. Thus, put briefly, in all save the Diacromyodean Passeres the *pars brevis* fails to reach the ectepicondylloid process of the humerus. In the Eurylæmid group it is very short, being confined to the upper end of the humerus; and this is true also of the Pittidæ in the Oligomyodean group; but in the Tyrannidæ this muscle extends more than halfway down the shaft. In this the Tyrannidæ agree with the Tracheophone Passeres, from which however they differ in the syringeal muscles, osteology, and pterylosis. Nevertheless, the differences between the wing-muscles in the Tyrannidæ and Pittidæ are differences of degree and not of kind.

Diacromyodean Passeres alone seem to have retained the *deltoides brevis* in its entirety: but even here it shows, in some Families, a very marked tendency to decrease, while, in others, on the other hand, it is relatively of great size. In the Muscicapidæ and Hirundinidæ it would seem to have preserved its most primitive character. In the former, this muscle is very thick and fleshy throughout its whole length up to the point of

insertion, where it becomes suddenly tendinous. In the *Hirundinidæ* it is also of great size, and joins the *deltoides major longus* to form a short, thick, fleshy column to be inserted into the ectepicondylar process. The d. m. longus is a relatively slender muscle in both these families; and this is true also of the *Gymnorhidæ* and *Paradiseidæ*.

The Families brought together in this paper, are, it is contended, all more or less closely allied. And this relationship is nowhere more easily traced than in the skull.

Throughout this series, the maxillo-palatine processes retain more primitive characters than in any of the remaining *Diacromyodean* Passeres: and these would seem to have been derived from the *Pittidæ* and *Tyrannidæ*. In the Tyrannine palate, as has already been remarked, the maxillo-palatines take the form of a pair of broad triangular plates; the apex of the triangle tending to curve towards the base of the skull.

The *Diacromyodean* types show an ever increasing tendency to transform this triangular plate into a long slender rod, curving towards the base of the skull, and terminating in a more or less spatulate, and sometimes inflated free end.

The *Campophagidæ* and *Muscicapidæ* well illustrate these phases, the more primitive showing the triangular, the more specialised the rod-like form. Other Families herein described show further and more peculiar characters of the palate which will be more particularly referred to in due course.

Broadly speaking, the Families now under consideration may be divided into two Groups—Flycatchers and Shrikes.

The Flycatchers (*Muscicapidæ* and *Campophagidæ*) most nearly approach the Tyrannine type; and are therefore to be regarded as the more primitive. Herein the maxillo-palatines are more or less triangular, and there is an ossified septum nasi dividing the palatine foramen into right and left moieties. Commonly, the inferior border of this nasal septum is expanded to form a flange.

The *Hirundinidæ* are generally regarded as very nearly allied to the *Muscicapidæ*. That they are related to this Family is, I think, a fact; but this alliance does not appear to be so close as is generally supposed. The Swallows indeed are a race apart.

In other words, the Swallows and Flycatchers are to be regarded as derivatives of the same generalised stock which have developed along independent, and more or less parallel lines. In so far as the skull is concerned, the Swallows recall some of the, presumably, more primitive *Tyrannidæ*. And this is especially the case with regard to the specialised condition of the maxillo-palatines and the relation of the palatines to the premaxilla: characters which appear to be, to some extent, adaptive, and correlated with the shortening of the beak and widening of the gape which apparently becomes necessary to ensure the successful

capture of small prey when on the wing. In the matter of the deltoideus muscles the Swallows do not differ greatly from the Muscicapine forms, but in their pterylosis they differ from all other Passeres, in that the *pteryla spinalis* is forked. This condition, however, may well have been derived from the breaking up of the lower segments of an elliptical tract enclosing a space, such as is seen in the Tyrannidæ, or the Muscicapidæ for example.

We may pass now to what I have regarded as the Laniine forms. These seem to be divisible into two groups including, among others, the following families of Dr. Sharpe's Hand-list:—Laniidæ, Prionopidæ, Artamidæ, Vangidæ, and Ærocharidæ. The Dicuridæ must also be included here, for they show, on the one hand, affinities with the Malaconotidæ, and on the other with the Prionopidæ. But many of these Families, as at present constituted, contain genera that cannot be allowed to remain there. While genera now included in other Families, outside this Group, will probably have to be transferred thereto.

We shall probably be near the truth in regarding the Laniidæ, Prionopidæ, and Malaconotidæ as representing so many branches of a common stem. Of this stem the Gymnorhine group must apparently be regarded as a sister branch, similarly splitting up into three branches—the Gymnorhinæ, Artaminæ, and Vangiinæ (if these two can really be separated), the Vireolanidæ, and probably the Paradiseidæ.

This Gymnorhine group may be distinguished by many characters, the most striking of which are afforded by the skull—the peculiar form of the palate, and the long postorbital processes already described in the earlier pages of this paper.

From this Gymnorhine branch it is probable the Paradiseidæ are derived. This latter Family, by the way, as it now stands, contains many forms which must be placed elsewhere. The Bower Birds (Ptilonorhynchidæ), for example, do not seem to possess any claim to be included here.

The distinctness of the Gymnorhine group has been ignored by many later workers, but there seems good reason to believe that W. K. Parker was justified in proposing therefore the term "Austro-coracæ."

As touching the Vireonidæ. This Family is regarded apparently, by some as allied to the Sylviidæ, by others to the Laniidæ. The latter view is certainly the more correct. But so far as my material goes, everything points to a near relationship to the Muscicapidæ. Of the six genera, however, usually included in this Family two at least must be removed; for *Cyclorhis* would seem to be very nearly allied to the Laniidæ, while *Vireolanus* is almost certainly closely related to the Artamidæ. This genus is probably an early offshoot of the branch which eventually gave rise to the Artamidæ, and may therefore either be included in this Family, or be allowed to rank as a separate Family; better

still perhaps the Artamidæ should be split up into two sub-families—Artaminæ, Vireolaniinæ.

I have been much puzzled as to the systematic position of the genus *Sphecotheres*. Generally regarded as one of the Oriolidæ, it seems to me much more nearly allied to the Campophagidæ, and should indeed be included in this Family. The skull bears a general resemblance to that of *Graucalus*. It is certainly not an Oriole; at any rate if the skulls in the Museum Collection are rightly labelled, and there seems to be no reason to doubt this. The fact that *Sphecotheres* has not developed the peculiar spiny rump-feathers so characteristic of the Campophagidæ may be urged, by some, as an objection to the introduction of this genus to the Family Campophagidæ. This, however, does not seem a very weighty objection, for the feathers in question vary in the degree of their spininess very considerably, in some genera it is hardly noticeable.

The genus *Tylas* again—which includes five species—has puzzled me greatly. Included by Dr. Sharpe with the Pycnonotidæ, it seems to me to belong rather to the Prionopidæ, though in some respects it recalls the Muscipidæ. It has certainly no affinities with the Pycnonotidæ.

The resemblances which the birds of the genus *Tylas* undoubtedly present, in many osteological characters, to the Laniine group are significant; and this because, curiously enough, they have been, and still are, regarded as “Babblers” (Pycnonotidæ) which have, for purposes of mimicry, assumed the guise of Shrikes!

Briefly, the genus *Tylas* includes five species, all of which are peculiar to Madagascar. All bear a strong likeness one to the other; and resemble scarcely less closely a member of the genus *Xenopirostris*—*X. polleni*. This bird is considered by some to be a Shrike, while by others it is, and probably rightly, included among the Artamidæ, or the closely allied Vangidæ—the two Families must I think be united. There are three species in the genus *Xenopirostris*, two of which are dull-coloured and bear no likeness to *X. polleni*. Thus all the five species of *Tylas* seem to have more or less completely assumed the livery of *X. polleni*. On the assumption that the genus *Tylas* belonged to the Pycnonotidæ, this resemblance to an aggressive Shrike was truly remarkable; but the likeness loses little of its interest even now that it is shown that this genus really belongs to Prionopidæ, a Family which must be included among the Shrikes.

Finally, I propose to arrange the Diacromyodean Families herein described in four groups, as follow:—

#### Suborder DIACROMYODI.

##### Group I. *Hirundines*.

##### Fam. 1. Hirundinidæ.

Group II. *Muscicapæ*.

- Fam. 1. Muscicapidæ.  
 „ 2. Campophagidæ.  
 „ 3. Vireonidæ (excluding *Cyclorhis*  
 and *Vireolanus*).

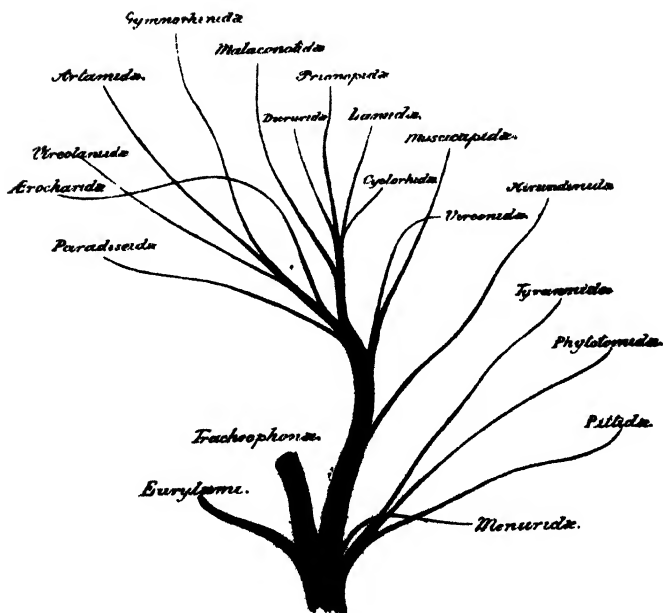
Group III. *Lanii*.

- Fam. 1. Laniidæ.  
 „ 2. Malaconotidæ.  
 „ 3. Prionopidæ.  
 „ 4. Dicruridæ.  
 „ 5. Cyclorhidæ.

Group IV. *Gymnorhines*.

- Fam. 1. Gymnorhidæ.  
 „ 2. Artamidæ.  
 „ 3. Vireolanidæ.  
 „ 4. Ærocharidæ.  
 „ 5. Paradiseidæ.

Text-fig. 104.



Phylogenetic tree indicating the probable relationships of the Passeres Oligomyodii and Diacromyodii.



## x. KEY.

The following "Key" gives the cranial characters of the Families dealt with in this paper.

## Suborder OLIGOMYODI.

Maxillo-palatines triangular; vomer truncated; nasal septum partly ossified; post-orbital process reduced; processus zygomaticus squamosi large; quadrate with a lateral pillar for articulation of the quadrato-jugal bar; a shallow temporal fossa extending as far back as the middle of the lambdoidal ridge.

*Tyrannidae.*

Maxillo-palatines in the form of broad linguiform plates sending up a slender spur into the lachrymo-nasal fossa; anterior palatal foramen nearly closed; maxilla with tubercles along the tomium; post-orbital process obsolete; processus zygomaticus squamosi greatly developed; quadrate with a vertical, lateral pillar for articulation of quadrato-jugal bar.

*Phytotomidae.*

Maxillo-palatines in the form of laminate spurs; vomer large, and deeply cleft posteriorly; post-orbital process small; processus zygomaticus squamosi large; nasal septum ossified; beak with a nasal hinge; temporal fossa separated by a moderately broad sagittal crest.

*Pittidae.*

## Suborder DIACROMYODI.

## Group I. HIRUNDINÆ.

Maxilla passing abruptly into the quadrato-jugal bar in the region of the antorbital plates, projecting laterad of the bar in the form of a wide ledge. Maxillo-palatines slender rods with spatulate free ends underlying the vomer. Nasal fossa large, septum nasi wanting; anterior palatine foramen of great size; external aperture of ear large, oval, directed downwards and outwards. Post-orbital process feebly developed.

*Hirundinidae.*

## Group II. MUSCICAPÆ.

Maxillo-palatines produced into flattened bands. Post-orbital process feebly developed, low down, and separated by a notch from the processus zygomaticus squamosi which is feebly developed. Temporal fossa greatly reduced or wanting.

a. Nasal septum ossified

*Muscicapidae.*

β. Nasal septum wanting

α'. Post-orbital process prominent; maxillo-palatines with hastate free ends

*Campophagidae.*

β'. Post-orbital process obsolete; maxillo-palatines with spatulate free ends

*Vireonidae.*

## Group III. LANIÆ.

Maxillo-palatines in the form of short, more or less triangular spurs with a palatal vacuity.

a. Post-orbital process feebly developed; processus zygomaticus squamosi large; nasal septum strongly developed

*Laniidae.*

β. Post-orbital process well developed; processus zygomaticus squamosi large; nasal septum imperfect; maxillo-palatines embracing facets on the vomer

*Malaconotidae.*

γ. Post-orbital process well developed; processus zygomaticus squamosi moderately large; nasal septum well developed; maxillo-palatine processes embracing facets on the vomer

*Dicruridae.*

δ. Post-orbital process well developed; processus zygomaticus squamosi obsolete; nasal septum nearly fitting palatal vacuity

*Prionopidae.*

e. Post-orbital process obsolete; processus zygomaticus squamosi large, conical; nasal septum feebly ossified; palatal vacuity nearly filled by septum nasi, and longitudinal osseous bar forming floor of vestibulum.

*Cyclorhidae.*

## Group IV. GYMNORHINES.

Palatal vacuity filled up by ossification of floor of vestibulum and nasal septum ; maxillo-palatines short hastate spurs underlying vomer.

- a. Post-orbital process and processus zygomaticus squamosi well developed, the former low down and separated from zygomatic process by a deep notch ; mesiad of zygomatic process of squamosal is a long slender style ; palatines with long spinous processes ; nasal fossa partly closed by ossification ; anterior narial aperture reduced to a small oval . . . . . *Gymnorhida.*
- β. Post-orbital process large ; zygomatic process of squamosal small, or obsolete ; the style mesiad thereof feebly developed ; palatines with spinous processes, short or obsolete ; nasal fossa partly closed ; narial aperture small, circular, lying in front of a larger oval vacuity . . . . . *Artamida.*
- γ. Post-orbital process obsolete ; zygomatic process of squamosal feebly developed ; nasal fossa open . . . . . *Vireolanida.*
- δ. Post-orbital process large ; zygomatic process of squamosal small ; nasal fossa closed ; narial aperture small, oval in shape ; beak enormously inflated ; a wide foramen, ventrad and distad of maxillo-palatine processes, leading into the air-chamber, which gives the inflated appearance to the beak . . . . . *Erocharida.*
- ε. Post-orbital process obsolete ; zygomatic process of squamosal well developed ; palatines with very short maxillo-palatal processes ; nasal fossa small, but co-extensive with narial aperture ; with an imperfect nasal hinge . . . . . *Paradisida.*

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Dr. J. ROSE BRADFORD, F.R.S., Vice-President,  
in the Chair.

The Secretary submitted the following report on the additions that had been made to the Society's Menagerie in March 1907:—

The registered additions to the Society's Menagerie during the month of March were 107 in number. Of these 66 were

acquired by presentation and 3 by purchase, 28 were received on deposit, 1 in exchange, and 9 were born in the Gardens. The total number of departures during the same period, by death and removals, was 163.

Amongst the additions special attention may be directed to:—

A pair of young Hippopotamuses (*Hippopotamus amphibius*) from German East Africa, purchased on March 2nd.

An Eland (*Taurotragus oryx*), born in the Menagerie on March 1st.

A Banksian Cockatoo (*Calyptrorhynchus banksi*) from New South Wales, deposited on March 15th.

Dr. A. Smith Woodward, F.R.S., F.Z.S., exhibited an antler of a Red Deer which had become malformed and enlarged by disease. The specimen was obtained by Mr. Thomas Sheppard from a prehistoric peat-deposit at Mablethorpe, Lincolnshire.

Mr. R. I. Pocock exhibited, on behalf of the Secretary, a model of the African Elephant “Jumbo,” formerly living in the Society’s Menagerie, made by the late Mr. William Prehn and presented to the Society by his widow.

Mr. C. J. With of Copenhagen communicated a paper entitled “An Account of the South-American *Cheliferina* in the Collections of the British and Copenhagen Museums.”

This paper will be published entire in the ‘Transactions.’

The following papers were read:—

# 1. The Ears as a Race-Character in the African Elephant.

By R. LYDEKKER.

[Received April 5, 1907.]

(Text-figures 105-121.)

That an animal with the immense geographical range of the African Elephant—a range extending from Nubia and Abyssinia in the north to the Cape of Good Hope in the south, and from the east to the west coast across the heart of the continent—should exhibit local differences is a practical certainty, even though it be admitted that the animal is naturally a wanderer. Such wanderings must, however, of necessity be limited in degree, and are not of the “Cape to Cairo” character which would be essential to cause uniformity in physical characteristics among all the local forms of the species. The existence of local variation in the species has, indeed, been well known for many years alike to sportsmen, naturalists, and ivory-dealers; and in 1890 Dr. Paul

Matschie \* proposed distinctive names for four of these local races.

In the discrimination of these races Dr. Matschie relied chiefly upon the characters afforded by the ears, supplemented by others derived from the skull; and it is quite obvious that in the case of an animal of the stature of *Elephas africanus* some such limitation of the bases of comparison is a practical necessity, seeing that entire mounted specimens are few and far between in our museums, while even mounted heads are comparatively uncommon. Unfortunately no figures of either the ears or the skulls have been published, so that it is in some instances a matter of considerable difficulty to satisfactorily identify Dr. Matschie's local races.

Under these circumstances, I have thought it advisable to make an attempt at putting matters on a more satisfactory footing by comparing the ears of such examples of the African Elephant as are available, either in the form of actual specimens or in the shape of photographs, and to figure some of the more striking types. I have taken the ear as the standard of comparison primarily for the reason that it was specially selected by Dr. Matschie; and, secondly, because, with the exception of the tusks, it is the one external portion of the animal which seems best suited for this purpose, and is likewise one of which examples are not unfrequently brought home by sportsmen.

The distinctive features afforded by the ear are exemplified not only by variation in the matter of contour, but likewise by differences in relative (and also in absolute) size. Why such differences should exist (or why, for that matter, the ear of the African Elephant should in all cases be so much larger than that of its Asiatic cousin) it is hard indeed to divine; but that they do exist, and in a very marked degree, will be apparent from the figures in this paper, all but one of which are reproduced from photographs. Then comes the question whether they are locally constant. To this question I cannot give an absolutely decisive answer. The specimens which I have had the opportunity of comparing agree, however, respectively with Dr. Matschie's descriptions of the typical examples from the same localities; while the numerous examples of the Sudan or Abyssinian Elephant which have come under my notice, and likewise several of the Cape Elephants, all conform in the matter of the size and shape of their ears to their respective local types. So far, therefore, as the available evidence goes, the various local representatives of the African Elephant do seem to be fairly constant in this particular; so that the *onus* of proving the opposite of this rests, I venture to think, with those who may take exception to the views here advanced.

In the matter of the relative size of the ear, it is important to

\* Sitz.-Ber. Ges. Naturfor. Berlin, 1900, pp. 189-190; a summary of the external characters of these races is given by the Hon. Walter Rothschild in an appendix to Major Powell-Cotton's 'A Sporting Trip through Abyssinia,' London (Rowland Ward, Ltd.) 1902.

notice that this appears to be subject to a certain amount of variation according to age; the proportionate size (as I infer from the specimen now in the Society's Menagerie) being greater in young animals than in those of riper age. It is thus evident that for the purpose of defining local phases of the species, comparison should be restricted, so far as the matter of size is concerned, to subadult or adult animals.

The following are the actual specimens that have come under my notice:—1st, the young Abyssinian Elephant now living in the Society's Menagerie; 2nd, a mounted head from the Lake Rudolf district, in the British Museum; 3rd, an entire mounted specimen from Fort Manning, N.E. Rhodesia (South Nyasaland), in the British Museum; 4th and 5th, two mounted heads in the Imperial Institute, one from Mashonaland, and the other reported to be from Swaziland; 6th, the right ear of an Elephant shot in Congo Territory by Major Powell-Cotton, which forms the *fons et origo* of the present communication. Mr. F. C. Selous has lent me the ears of an Elephant shot by himself in Mashonaland, one of which is now exhibited; and I am also enabled to show, through the courtesy of the owner, the right ear of a huge Elephant killed by Mr. A. Haig on the Blue Nile, and the head of a male Somali Elephant belonging to S.A.R. le Duc d'Orléans. The head of an East African Elephant with very long tusks in Mr. Rothschild's museum at Tring came under my notice after the paper was read.

Of all these specimens, except the first and last, photographs are herewith exhibited, and I may take this opportunity of thanking the Director of the Imperial Institute for permission to photograph the two heads under his charge.

In addition to the above, I have been provided with the following photographs:—1st, a South Somali Elephant in the act of charging, photographed by Mr. R. McD. Hawker; 2nd, "Jumbo" and the "Queen's Elephant," both formerly living in the Society's Menagerie; 3rd, an Elephant from the Aberdare Mountains, in the private museum of Mr. C. V. A. Peel at Oxford; 4th, the photograph of the head of an Elephant from the Galla Country, belonging to Sir E. G. Loder; 5th, the head of an Elephant shot by the Duke of Westminster in North-west Rhodesia, now mounted at Eaton Hall; 6th, the head of an Elephant shot by H.R.H. the late Duke of Saxe-Coburg-Gotha in Cape Colony, now at White Lodge, Richmond; 7th, the head of a female South African Elephant in the Museum at Cape Town; 8th, the head of a female of the same race in the Museum at Saffron Walden; 9th, two Elephants from the Addo Bush, near Grahamstown. For No. 3 I am indebted to Mr. Peel, for No. 4 to the Duke of Westminster, for No. 5 to Rowland Ward Ltd., for No. 6 to the Director of the South African Museum, for No. 7 to the Curator of the Saffron Walden Museum, and for No. 8 to the Director of the Grahamstown Museum; and to all these donors my best thanks are due.

After reading the paper, I received from Mr. Frederick Gillett the photograph of an Elephant shot by himself in the Arusa Galla Country (Long.  $41^{\circ}$  E., Lat.  $7^{\circ} 30'$  N.).

Before going farther, it may be well to mention that some additional difficulty has been introduced into the work of comparison, owing to the ears of some of the specimens being in the "cocked" and others in the recumbent position, and likewise owing to certain differences in the orientation of the photographs. To these difficulties, which I have endeavoured so far as possible to discount, must be added any that may be due to vagaries on the part of the taxidermists who have set up the various specimens.

Text-fig. 105.



Head of the Aldo Bush, or East Cape Elephant (*Elephas africanus capensis*), from an adult male specimen in the Grahamstown Museum.

With these preliminary remarks, attention may be directed to Dr. Matschie's description of the ears and other external characters of his four races. A free translation of the original paper enables these to be given as follows, viz. :—

1. In the Southern race (*Elephas africanus capensis*) the ears are enormous, somewhat square in shape, with rounded corners, and a small, distinct, sharply pointed angular lappet in front. The

forehead falls away towards the temples, so as to appear highly arched.

II. The Western race (*E. africanus cyclotis*), typically from South Cameruns, also has the ears very large, but of quite different shape, the contour being oval, and the lappet in the form of a half-ellipse. The skin has a mosaic-like appearance, and its colour is a paler grey than in the third race.

III. In the Sudan race (*E. africanus oxyotis*) the ears are considerably smaller and semicircular in shape, with the front lappet very sharply pointed and angular.

IV. The East African race (*E. africanus knochenhauseri*), typically from German East Africa, has still smaller ears, which are triangular in shape, with the front lappet angulated and pointed.

In addition to these, a dwarf race of Elephant from the Congo (*E. africanus pumilio*), which may not have exceeded 7 feet in height, has been named by Prof. T. Noack\*; while the Albert Nyanza Elephant has been separated by myself† as a distinct race, under the name of *E. africanus albertensis*, characterised by certain peculiarities in the form of the skull, which is unusually short and broad.

Dr. Matschie, it should be added, was of opinion that the Congo and the Angola Elephant might also be racially distinct, while two or three other races might be represented in other parts of Africa.

Here a word of explanation may be given with regard to the element indicated by the word "lappet" in the foregoing definition of Dr. Matschie's races. This, I take it, refers to the antero-internal angle of the ear, which forms a more or less distinct lobe, and, as in text-fig. 106, may be inflected.

As Dr. Matschie commenced with the South African Elephant, the same course may be followed on the present occasion. Here, however, a difficulty at once presents itself, for there appear to be two distinct southern forms of the species, one from the eastern and the other from the western side of Cape Colony. It was to the Eastern form, as represented by an Elephant from the Upper Orange River district, that Cuvier gave the name of *Elephas capensis*; and since specimens from the same district afforded Dr. Matschie the materials for his definition of the race described under that name, we must apparently accept this determination of the race, which may, however, really be inseparable from Blumenbach's *E. africanus typicus*, based on teeth from a locality unknown.

A male Elephant from the preserves in the Addo Bush near Port Elizabeth, mounted in the Grahamstown Museum, of which the right side of the head is shown in text-fig. 105, agrees in the squared form of the ear exactly with Dr. Matschie's definition of

\* Zool. Anz. Leipzig, vol. xxix. 1906, pp. 631-636.

† 'The Field,' vol. cvii. 1906, p. 1089.

*E. africanus capensis*, and may accordingly be referred to that race. The inner front edge of the lappet is turned in towards the neck. The high arching of the profile of the forehead referred to by Dr. Matschie is strongly pronounced in the photograph, as it is in the photograph of a second and younger specimen in the Grahamstown Museum, which agrees precisely in the form of the ears with the first example. I may add that the Director of the Grahamstown Museum, to whom I am indebted for these photographs, has been long convinced of the racial distinctness of the Addo Bush Elephant, and has given me the following additional particulars of the animal. The ears, compared to those of the next race, are small, and the fore-legs proportionately low; while the ventral line of the body is almost horizontal. More important is the presence of a dense coat of hair on many parts of the body; this being very noticeable in the specimen of which the skeleton is now mounted in the Oxford Museum.

Text-fig. 106.



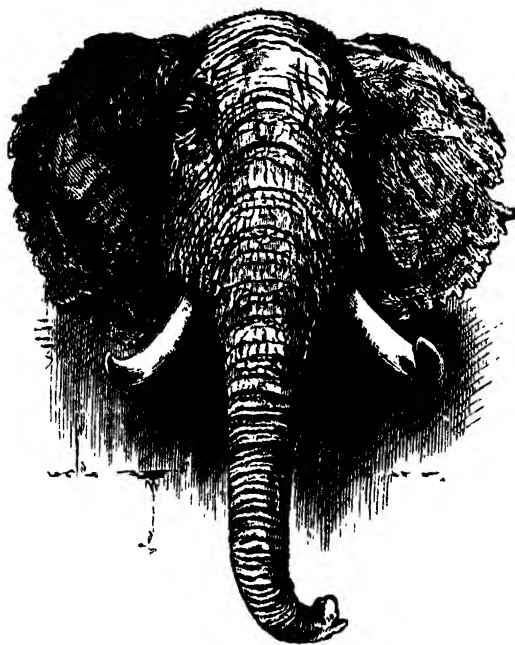
Head of Female West Cape Elephant (*Elephas africanus torotus*), from a specimen in the South African Museum, Capetown.

If we call the preceding form the Addo Bush, or East Cape Elephant, the race to which attention is now directed may be termed the West Cape Elephant. That it is perfectly distinct



from *E. africanus capensis* is, I think, certain, the ears being relatively larger, and not having the slightest tendency to a squared form. This is well exemplified by the photograph of the head of an entire female specimen in the South African Museum at Cape-town (text-fig. 106), which may be taken as the type of this race. The ears are very long, somewhat in the form of a half-oval or perhaps of half a pear, with the lappet moderately large, not markedly pointed, but strongly inflected towards the neck. Apparently the ears do not quite meet, when in repose, in the middle line of the neck, and they are much larger in proportion to their width than in the Addo Bush Elephant, in which, as already mentioned, they approach a square. So far as I can learn. the skin is not hairy.

Text-fig. 107.



Head of Male West Cape Elephant (*Elephas africanus torotus*), from a specimen shot by H.R.H. the late Duke of Saxe-Coburg-Gotha in South Africa, and now at White Lodge, Richmond.

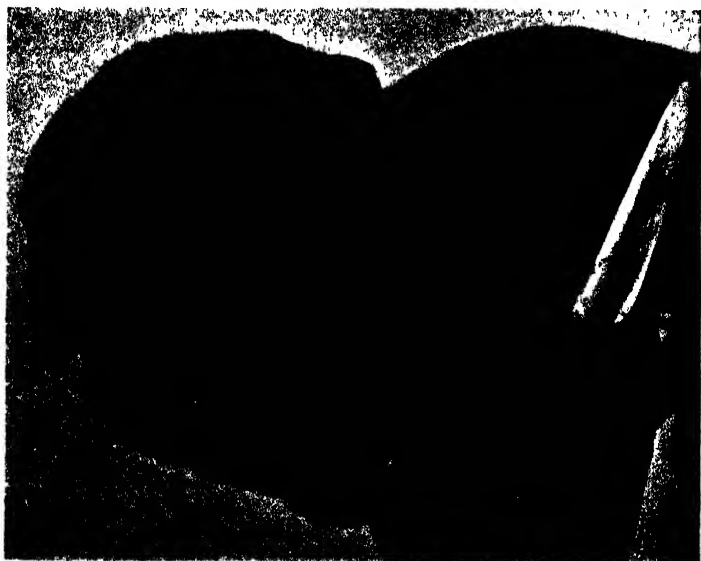
Unfortunately, I have not the dimensions of the ears of either the Cape Town or the Grahamstown specimen. Livingstone in his 'Missionary Travels'\* has, however, recorded that in a female elephant standing 8 feet 8 inches in height, the ears measured 4 feet 5 inches in vertical depth by 4 feet in horizontal diameter.

\* Small edition, page 370.

While indicating the large size of the ears characteristic of South African Elephants generally, these dimensions are suggestive of the Addo Bush type.

Reverting to text-fig. 106, it may be noticed that the arching of the forehead is less marked than in the Addo Bush Elephant. Nearly similar features are displayed in the photograph of the head of an immature South African Elephant in the Museum at Saffron Walden, Essex, which was acquired somewhere about the year 1850, but the ears, in correlation with its immaturity, are relatively larger. The front view of the head of a male elephant shot during (I believe) the sixties by H.R.H. the late Duke of Saxe-Coburg-Gotha in South Africa (text-fig. 107) seems undoubtedly to belong to the present type, the ears being of the same large semielliptical form, and not rising, when cocked, above the line of the middle of the head.

Text-fig. 108.



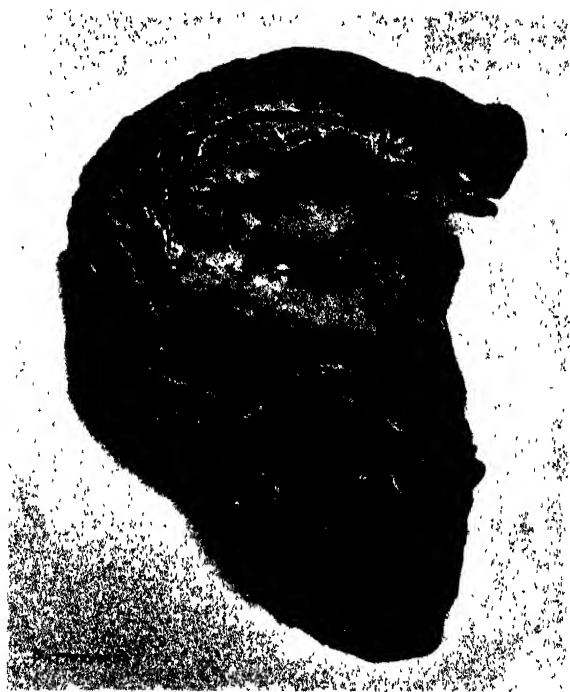
Head of Male Mashonaland Elephant (*Elephas africanus selousi*) in the Imperial Institute.

Assuming that I am justified in separating the West Cape Elephant, which survives only in a few protected localities, such as Mossel Bay, from *E. africanus capensis* as typified by the Addo Bush Elephant, the former will require a new name (unless indeed it be *E. africanus typicus*). I accordingly suggest the

name *E. africanus toxotis*, taking the specimen shown in text-fig. 106 as the type.

I now pass to the head of a male Elephant in the Imperial Institute, shot by Mr. James Sligo Jameson. This Elephant (text-fig. 108), as I learn from a footnote on page 433 of Mr. Selous' 'A Hunter's Wanderings in South Africa,' was shot by Mr. Jameson in Matabililand (South Rhodesia).

Text-fig. 109.



Right Ear of Male Mashonaland Elephant (*Elephas africanus selousi*),  
from a specimen belonging to Mr. Selous.

Mr. Selous has kindly lent me the right ear of another Elephant (text-fig. 109) shot in Mashonaland (Rhodesia), which apparently belonged to the same race as Mr. Jameson's Elephant. This ear has now a vertical diameter of 4 feet 8 inches, but when fresh it is stated to have measured 5 feet 6 inches. None of the upper margin is now reflected, but in life about four inches appears to have been turned back, as in *E. a. knochenhauseri*. The height of the elephant to which it belonged was about 10 feet. The ear is

much less elliptical than in *E. a. toxotis*, and approaches more to that of the undermentioned *E. a. cyclotis*, but agrees with the former in that the lappet underhangs part of the lower jaw and chin.

I think I am justified in regarding the Mashonaland Elephant as a distinct race, for which the name *E. africanus selousi* would be appropriate; the specimen in the Imperial Institute being regarded as the type.

This race will be characterised by the ears being of considerable size, with the margin rounded, and the inferior lappet large, pointed, and extending inwards to some extent beneath the lower jaw and throat. In this respect they are unlike those of other East African Elephants. Perhaps it may not be impertinent to suggest to the authorities of the Imperial Institute that this interesting specimen requires careful repairing at the hands of a skilled taxidermist.

Text-fig. 110.

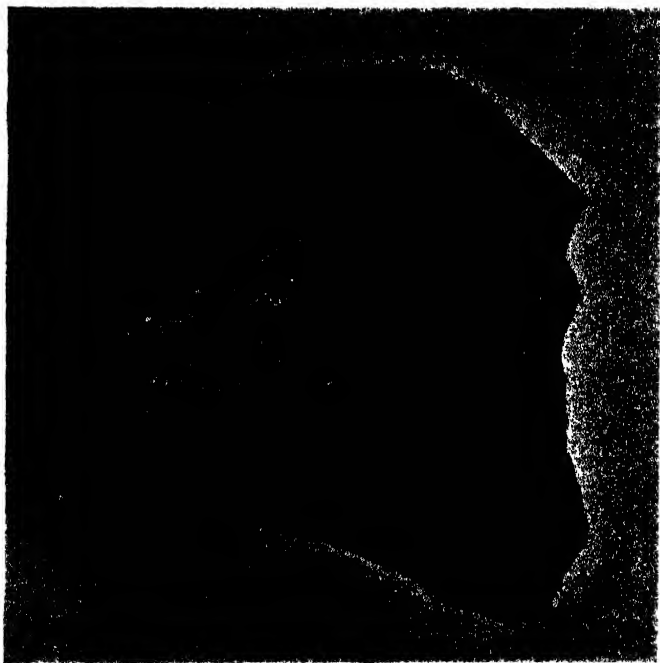


Head of Male Elephant from Swaziland, in the Imperial Institute.

A second head in the Imperial Institute (text-fig. 110) is stated to have been obtained from Swaziland. The ears are in bad condition, and I am unable to come to any certain conclusion as to the race represented by this specimen, which appears, however, to approximate to the Mashonaland type.

The next specimen for consideration is the ear of the Congo Elephant killed by Major Powell-Cotton (text-fig. 111). The whole contour is regularly rounded, and the transverse diameter relatively large. That this type is quite different from the ear of *E. africanus toxotis*, as typified by the specimen represented in text-fig. 106, is perfectly evident. Exclusive of the lappet, this ear might well be described as oval; the lappet itself being broad, blunt, and short. It thus accords in general character with the

Text-fig. 111.



Right Ear of the Congo Elephant (*Elephas africanus cyclotis*?), from a male killed by Major Powell-Cotton.

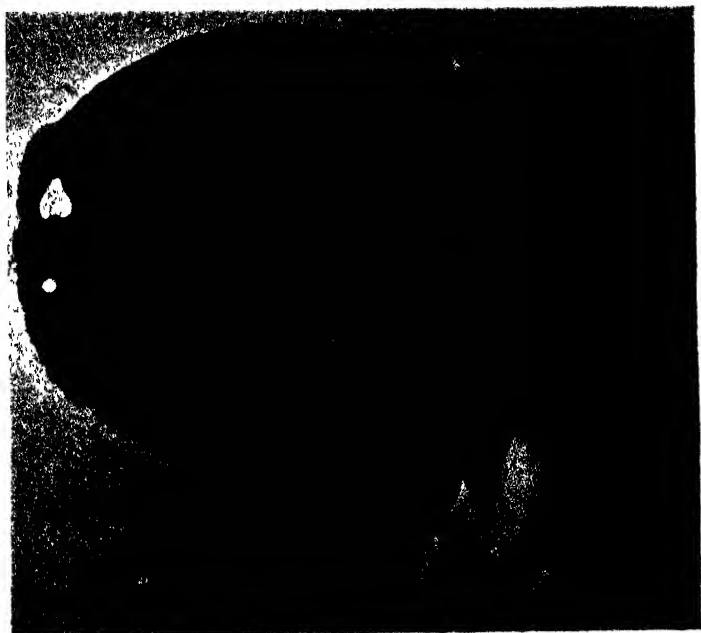
*E. africanus cyclotis* of Dr. Matschie, from the South Cameruns; but in the absence of a figure of the type of the latter it is impossible to say how close the resemblance really is. Under these circumstances, all that can be done is to refer Major Cotton's specimen provisionally to the Cameruns race, with the suggestion that if it prove distinct it should be named after the gallant explorer.

The Congo Elephant, it may be added, differs from both the

southern races in the large size of its tusks, which are, however, frequently of a somewhat slender type.

Attention may now be directed to several photographs (text-figs. 112-116) of Elephant-heads from various parts of the eastern side of Africa north of the Orange River, the ears of all of which are characterised by the tendency to the assumption of a more or less distinctly triangular form and by the pointed extremity of the lappet, which is not inflected, and stands out quite distinct from the side of the head. Dr. Matschie's *E. a. knochenhaneri* and *E. a. ocyotis* both pertain to this group; but whereas I have no difficulty in identifying the latter type, it is less easy to decide whether any one of my specimens should be identified with the former, which is typically from German East Africa.

Text-fig. 112.



Head of a Male Elephant from North-west Rhodesia, in the possession of the Duke of Westminster.

I take first the head in the possession of the Duke of Westminster (text-fig. 112), which I am told was killed by his Grace in North-western Rhodesia. In this specimen the ears are of medium size, rising, when cocked, slightly above the vertex of the head, with the superior border nearly straight for some

distance, and the margin then forming a regular curve till the width begins to narrow, when it runs obliquely to the extremity of the small lappet which forms a symmetrical triangle. Although I have but little doubt that this specimen represents a distinct race, I do not intend to propose a name, on account of its not being in a well-known collection.

I now come to the male Elephant from Fort Manning, N.E. Rhodesia (Nyasaland), mounted in the British Museum (Natural History), of which the right side of the head is shown in text-fig. 113. The most striking features of the ear in this specimen are its relatively small size and distinctly triangular shape; the upper border, which rises considerably above the vertex of the skull and is reflected posteriorly to a depth of several inches, being

Text-fig 113.



Head of Male Elephant from Fort Manning, N.E. Rhodesia (*Elephas africanus knochehaueri* ?), from the entire specimen in the British Museum.

strongly arched and terminating in a marked angle which forms the outermost point of the ear, while the lower and inner borders form nearly straight lines meeting in the angular apex of the lappet. The small relative size of the ear is indicated by the fact that whereas the height of the specimen is 11 feet 4 inches, the vertical diameter of the ear (inclusive of the reflection) is 4 feet 2½ inches and the transverse diameter 3 feet 5 inches; the dimensions of the ear thus being considerably inferior to those in the Cape Elephant of 8 feet 8 inches in height recorded by Livingstone. In addition to its small and triangular ears, the North-east Rhodesian Elephant is also characterised by its relatively small head and tusks. Although the dimensions and a figure of

the ears of *E. africanus knochenhaueri* are not available, the Rhodesian animal clearly comes very close to that race (of which the type specimen came from German East Africa), and is accordingly, at any rate for the present, considered to be inseparable therefrom.

Text-fig. 114.



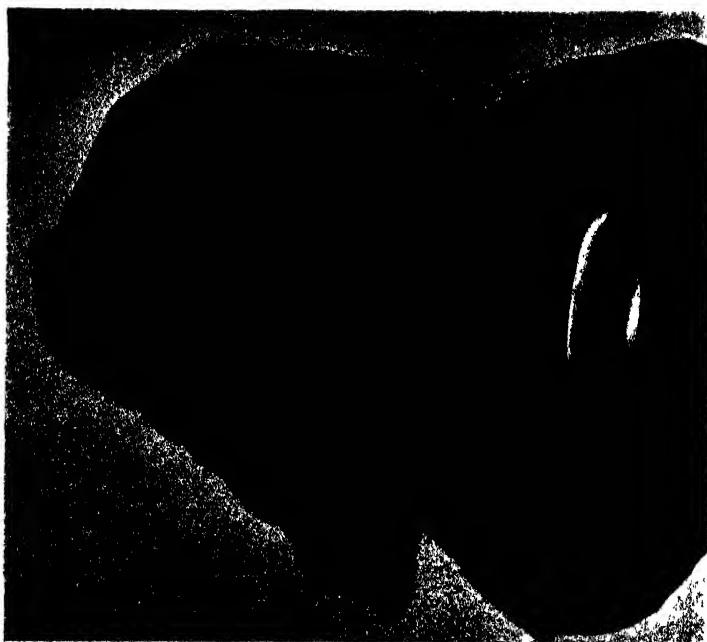
Head of Male Elephant from the Aberdare Mountains, British East Africa (*Elephas africanus peeli*), from a complete specimen in the collection of Mr. C. V. A. Peel at Oxford.

Next on the list comes an Elephant in the private collection of Mr. C. V. A. Peel, 12 Woodstock Road, Oxford, shot in the Aberdare Mountains, British East Africa, which are situated immediately east of the Victoria Nyanza, at no great distance from Mount Kenya. The ears of this specimen (text-fig. 114), which are mounted "cocked," are remarkable for their length and narrowness and somewhat pyriform shape; the vertical diameter being 4 feet 3½ inches and the transverse 2 feet 5 inches.



The upper border is strongly arched, with the curvature continued along the outer margin, where there is no angulation, for a considerable distance, after which the ear rapidly narrows to the extremity of the long and pointed lappet. The tusks are large and of a relatively slender type. If I am right in identifying the North-east Rhodesian Elephant with *E. a. knochenhaueri*, it seems perfectly evident that Mr. Peel's animal must represent another race, which is equally distinct from the more northern *E. a. oxyotis*.

Text fig. 115.



Head of Male Elephant from the Lake Rudolf District (*Elephas africanus cavendishi*), shot by Mr. H. S. H. Cavendish, and now in the British Museum (Natural History).

Since the above was written Mr. Rothschild has sent me a photograph of the Elephant's head from South-east Africa in his museum, to which reference is made on page 282. It appears in all respects similar to the head of Mr. Peel's specimen, and may be referred to the same race, of which the long slender tusks form a feature. For this race I propose the name *E. africanus peeli*, making Mr. Rothschild's specimen a "co-type."

¶ From the comparative nearness of the Lake Rudolf district to the Aberdare Mountains, it might be reasonable to suppose that the

same type of Elephant would be found in both areas. The head of an elephant from the former district, shot by Mr. H. S. H. Cavendish and now in the British Museum (text-fig. 115), appears, however, to be distinct from Mr. Peel's specimen, though the ears are of the same general type in the two. Owing to the different angles at which the photographs have been taken, it is difficult to determine whether or no the ears of the present specimen rise so high above the vertex as in Mr. Peel's elephant. They are, however, relatively broader (vertical diameter 2 feet 10 inches, transverse diameter 2 feet 11 inches), and show a decided, although not sharp, external angle, while the lappet is shorter and sharper. They are considerably reflected at the sides, but scarcely at all at the top. I think I may venture to make this specimen the type of a race, with the designation *Elephas africanus cavendishi*. It will be distinguished from *E. a. knochenhaueri* (as represented by the British Museum specimen) by the larger and less distinctly triangular ear, of which the upper border is more regularly convex, the outer angle less defined, and the lappet longer and narrower.

To *E. a. cavendishi* may be assigned the head of a bull Elephant shot in the Galla Country, on the south-west border of Somaliland, in the museum of Sir E. G. Loder, to whom I am indebted for the photograph of it. The Galla Country is no great distance from Lake Rudolf, and Sir E. G. Loder's specimen is so like the one given by Mr. Cavendish to the British Museum that the photograph of the former might almost be mistaken for that of the latter. I think Mr. Gillett's elephant also belongs to this race.

Here I may refer to a very interesting photograph of a male South Somali Elephant taken in the act of charging, with its ears cocked, by Mr. B. McD. Hawker in 1906, and presented by him to the British Museum. The small scale of the photograph does not admit of any definite statement with regard to this elephant, which seems to have proportionately smaller ears than the foregoing specimens.

Next on the list of races named on the evidence of the contour of the ear comes the Sudan, or Abyssinian Elephant (*Elephas africanus oxyotis*) of Dr. Matschie, typically from the Upper Atbara Valley, of which numerous examples have been recorded. Dr. Matschie describes the ears as semicircular, with a very long and sharp lappet. A very long and narrow triangle, of which the upper side is convex, terminating inferiorly in a long, sharp, forwardly-directed lappet, with the upper border reflected forwards and the two ears overlapping in the middle line when in repose, seems a better definition. It must, however, be admitted that precise definition of the ear-characters of the various races is almost an impossibility, and that reference to figures or specimens is essential. With regard to the value to be attached to the forward bending of the upper rim of the ear, I am uncertain. In many mounted specimens this rim is backwardly reflexed; but

whether this is correct, or whether the condition alters according as to whether the ears are in repose or cocked, I am unable to state.

Text-fig. 116.



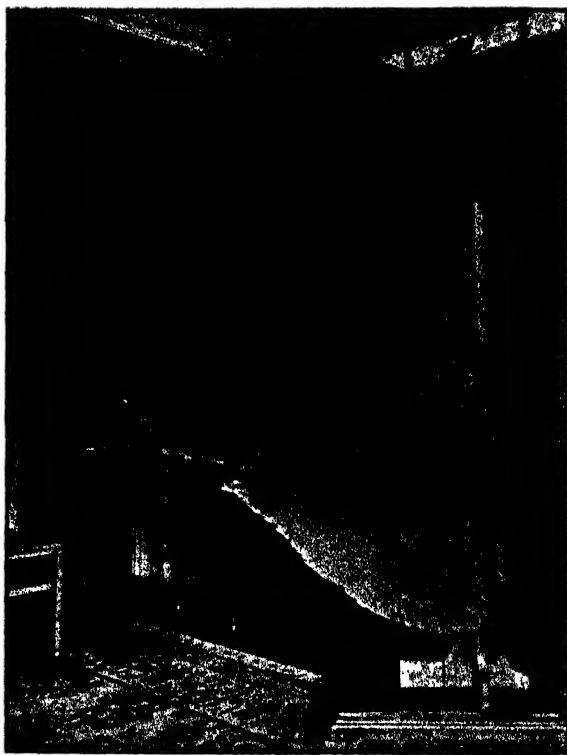
Head of the "Queen's Elephant," an immature Male Sudan Elephant (*Elephas africanus oxyotis*), formerly owned by the Society.

I take as a typical example of this race the head of the well-known "Queen's Elephant" formerly in the Society's collection (text-fig. 116). This animal came from Abyssinia. A second example of the same race is the young Abyssinian Elephant now living in the menagerie in the Regent's Park, whose ears accord very closely in shape with those in the photograph of the "Queen's Elephant."

The largest ears I have seen are those of an Elephant killed by Mr. A. Haig on the Blue Nile, one of which is shown in text-fig. 117. This specimen, as mounted (possibly with some stretching), has a maximum vertical diameter of no less than

6 feet  $5\frac{1}{2}$  inches, and a transverse diameter of 4 feet  $1\frac{1}{2}$  inches. The height of the animal to which it belonged is estimated by the owner (from the circumference of the fore-foot) to have been over 13 feet. Mr. Haig also possesses the ears of another Elephant from the same district, which are rather smaller. As mounted, neither of these ears shows any fold at the top; although, as already mentioned, in the "Queen's Elephant," as well as in

Text-fig. 117.



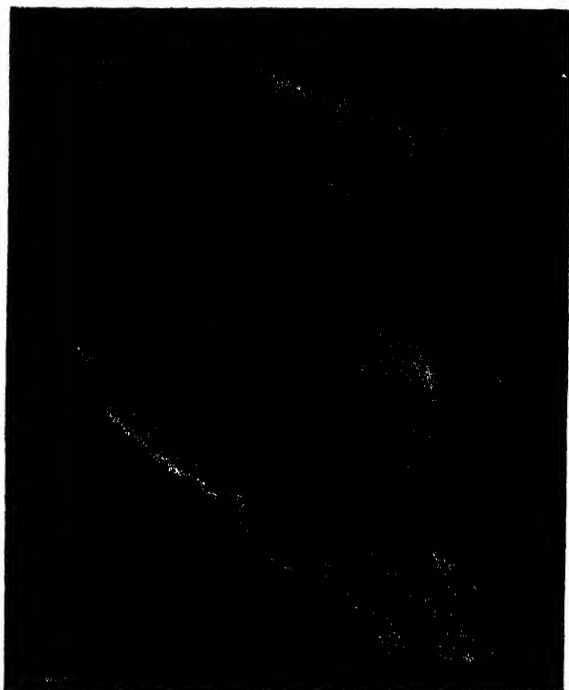
Right Ear of a Male Sudan Elephant (*Elephas africanus oxyotis*), from the Blue Nile, in the possession of Mr. A. Haig.

the young Abyssinian Elephant now living in the Society's Gardens, there is a small forward fold. The enormous length of the ears of this race is indicated in the photograph of a herd at the Giza Zoological Gardens sent me by Captain S. S. Flower, where this feature is well displayed in one full-grown animal. Despite the gigantic stature attained by *E. a. oxyotis*, the tusks

in this race seem to be small and sharply curved; those of Mr. Haig's larger specimen weighing less than 60 lbs. each.

While the Elephant of the Blue Nile appears inseparable from the Abyssinian form, i. e. *E. a. oxyotis*, I am informed by Mr. Haig that the Elephants of the White Nile are quite distinct, having relatively small ears.

Text-fig. 118.



Right Ear of the North Somali Elephant (*Elephas africanus orleansi*), from the type specimen in the collection of S.A.R. le Duc d'Orléans.

Whether the White Nile Elephant is or is not identical with the one inhabiting Somaliland, I am unable to say; but the head from the latter district belonging to the Duc d'Orléans (cf. text-fig. 118) clearly indicates a race markedly distinct. This race, which I propose to call *E. africanus orleansi* (with the type specimen in the collection of the Duc d'Orléans at Wood Norton), is characterised by the very small size of the ears, which do not reach within a considerable distance of the lower jaw and throat, and are proportionately not much larger than those of *E. a. knochenhaueri*, although of quite different shape. In the

specimen figured, which indicates a small, although apparently adult elephant, the maximum vertical diameter of the ear is only 2 feet 11 inches, and the transverse diameter 2 feet. The ears, which (as mounted) show no folding, are remarkable for the circumstance that their upper margin is almost continuous with that of the head itself; the distinct notch occurring at the junction of the ear with the head in all other Elephants that I have seen, being absent. The upper margin of the ear forms a nearly straight line inclining upwards to the outer upper angle; from the latter point the outer margin runs nearly vertically downwards for a considerable distance, and is then continued for a much longer distance in a downward and inward direction to terminate in the point of the inferior lappet. The lappet itself is small, triangular, sharply pointed inferiorly, and separated by a wide notch from the side of the lower jaw and throat. It seems, indeed, to form a semi-distinct appendage of the ear, and is thus quite unlike the corresponding element in any other head that has come under my notice. The distinctness of the North Somali Elephant, as it should be called, is thus perfectly apparent.

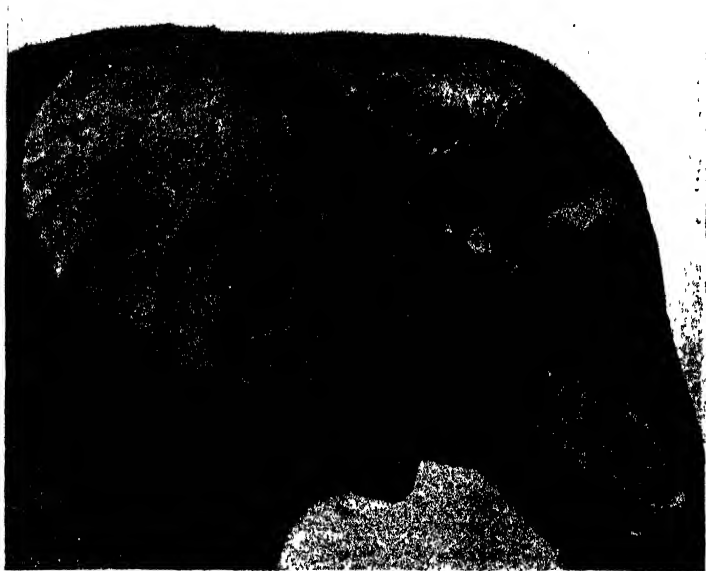
The next race for consideration is the one from the French Sudan, typified by "Jumbo," the Society's well-known African Elephant. "Jumbo," together with "Sahib," who died last year after a sojourn of about thirty years at Paris, was brought to France from some part of the French Sudan\*, probably to the southward of Lake Chad, and afterwards sold to our Society. At the time he left England for America he was believed to be about 11 feet in height; and both he and "Sahib" indicate an unusually large race of the species. As regards the characters of the ear, the West Sudan race appears to connect the East African races with *E. a. cyclotis*. Compared with that of *E. a. oxyotis* (text-fig. 117) the ear of "Jumbo" (text-fig. 119) is relatively smaller, and has a strongly emarginate, in place of a nearly straight postero-inferior border. The emargination of this border causes the lappet to be much more distinct from the rest of the ear than is the case in *E. a. oxyotis*; and if this semidistinct lappet were altogether removed, we should have an ear not very unlike that of *E. a. cyclotis*. Jumbo's ears, when in repose, nearly meet in the middle line of the back, and show no flexure of the margin, whereas the upper border of those of *E. a. oxyotis* is bent over the front surface. A marked peculiarity in the case of "Jumbo" is the deep channel running upwards and backwards from the meatus. The subpyriform shape of the ear, with the above-mentioned groove, and the absence of any flexure of the margin, appear to be the most easily recognised features of the large West Sudan race, which I propose to call *E. a. rothschildi*, taking the statuette of "Jumbo" in the British Museum (Natural History) as the type.

Thus ends this long review of the various forms of ear

\* This information was given me by Mr. Rothschild after the paper was read.

presented by the Elephants that have come under my notice. Possibly it may be pronounced an unsatisfactory one; and it is confessedly but a preliminary recognisance, written in the hope that it may lead to more definite results. Before such results can be attained it is of prime importance that the British Museum should obtain mounted heads of a number of Elephants from different parts of Africa; and the assistance of sportsmen towards this object is earnestly invoked, as if the work is to be done at all, it is all important that it should not be delayed. I may also express the hope that Dr. Matschie will speedily see his way to publish photographs of the ears of the type specimens of the four races recognised by himself.

Text-fig. 119.



Head of "Jumbo," the male West Sudan Elephant formerly belonging to the Society.

In regard to the dwarf Congo Elephant (*Elephas africanus pumilio*) of Prof. Noack, this appears to be characterised, according to our present information, primarily by its small stature, which is estimated to be about 7 feet. There is, however, no definite information even on this point, as the living specimen, now in America, upon which the description was based is immature. According to a note kindly communicated to me by Dr. Chalmers Mitchell, this Elephant differs from the other races of the species by the unusual shortness of the "finger" on the

lower border of the tip of the trunk and unusual length of the upper "finger." It also appears to have a darker skin than in *E. a. cyclotis*. (See *infra*, p. 447.)

In conclusion, reference may be made to my account in the 'Field' newspaper for 1906\* of the skull of an Elephant killed by Mr. Stanley C. Tomkins at the south end of the Albert Nyanza. Mr. Tomkins, who presented the skull to the British Museum,

Text-fig. 120.



Front view of the Skull of the Sudan Elephant (*Elephas africanus oryotie*).

also forwarded a photograph of the dead elephant as it lay on its side in scrub-jungle. Unfortunately the photograph does not show the complete contour of the ear; but the portion visible, although apparently of the triangular type, does not seem to agree with the ear of any of the specimens referred to above. According to information supplied by Mr. Tomkins, both the natives of the Albert Nyanza and sportsmen who have visited

\* Vol. cvii. p. 1089 (1906).



the district, are convinced of the distinctness and peculiarity of the race of Elephants inhabiting that portion of forest country lying to the south-west of the Albert Nyanza, in Congo territory.

Compared with a skull of *E. africanus oxyotis* presented to the British Museum by the late Sir Samuel Baker (text-fig. 120), the Albert Nyanza skull (text-fig. 121), while much inferior in total length, is considerably wider across the forehead between the temporal fossæ. The forehead is also much flatter, the pit between the sheaths for the tusks is shorter and shallower, and the sheaths themselves are shorter and less divergent. There are likewise marked differences in the occipital and lateral aspects of the two skulls.

Text-fig. 121.



Front view of the Skull of the Albert Nyanza Elephant (*Elephas africanus albertensis*).

The skull is further remarkable for the great relative stoutness of the zygomatic arch, which is absolutely thicker than in the larger figured skull of *E. a. oxyotis*, the large size of the infra-orbital foramen, and the great thickness of the terminal alveolar portion of the premaxillæ.

On one side of the upper jaw the two molars (penultimate and last) are preserved, the former having the normal eight plates.

Apart from the fact that all the other skulls of African Elephants (some old and some young) in the British Museum are of the same general type, such differences cannot be attributed either to age or to individual variation. Indeed, if the Albert Nyanza skull had been found in a fossil condition without the teeth, there would be little hesitation on the part of naturalists in regarding it as specifically distinct from the African Elephant.

The Albert Nyanza skull, it may be added, is quite different from that of the Rhodesian Elephant referred to *E. a. knochen-haueri*, and apparently also differs as markedly from Dr. Matschie's description of that of the type specimen of the latter. The ear, moreover, in Mr. Tomkins's photograph is certainly different from that of the Rhodesian Elephant in the British Museum. A small telephotograph of an elephant killed by Major Powell Cotton on the Semliki side of the Albert Nyanza, recently published in the 'Illustrated London News,' may belong to this race, and appears to have an altogether peculiar type of ear. Under these circumstances the name of *Elephas africanus albertensis*, which I suggested in the 'Field' for the Albert Nyanza Elephant, may stand.

The most noteworthy feature about the skull of *E. a. albertensis* is its striking resemblance in contour to that of *E. planifrons* of the Pliocene of the Siwalik Hills of Northern India, as will be apparent by a comparison of the figure here given (text-fig. 121) with the one of the fossil skull represented in plates ix. and x. of Falconer and Cautley's 'Fauna Antiqua Sivalensis.' *E. planifrons* is a member of the "loxodont" group, with a ridge-formula very similar to (although slightly higher than) that of *E. africanus*, and one displaying primitive features in the development of successional premolars.

Although accepting the view of the African origin of the Proboscidea, I am of opinion (from the occurrence in those countries of the intermediate "stegodont" group) that the evolution of the Mastodons into Elephants probably took place somewhere in South-eastern Asia; and the similarity presented by the skull of *E. africanus albertensis* to that of *E. planifrons* seems to suggest that the African Elephant may be the descendant of the fossil Indian species. The many remarkable instances of affinity between the Pliocene mammals of India and the modern mammals of Africa (among which the relationship of *Canis curvipalatus* to *Otocyon* is one of the most noteworthy), indicate that there is no inherent improbability in such an ancestry for *Elephas africanus*, of which, on this view, *E. a. albertensis* is the most generalised representative.

[*Postscript.*—A second Elephant's head in Mr. Rothschild's museum, from some part of East Africa, appears to indicate an animal nearly allied to the one from Swaziland of which the head is represented in text-fig. 110 (p. 389).]

2. The Duke of Bedford's Zoological Exploration in Eastern Asia.—IV. List of small Mammals from the Islands of Saghalien and Hokkaido. By OLDFIELD THOMAS, F.R.S., F.Z.S. (With Appendix on the Cold-blooded Vertebrates, by G. A. BOULENGER, F.R.S., F.Z.S.)

[Received March 21, 1907.]

Whatever may be the riches of the St. Petersburg Museum in collections from the far-eastern island of Saghalien, our own National Museum has hitherto possessed scarcely a single mammal from it, so that the results of a visit made to the island by Mr. M. P. Anderson during last summer, presented to the Museum by our President, are of the greatest value, and include examples of a considerable number of species and subspecies new to science.

Mr. Anderson also paid a second visit to the island of Hokkaido (formerly known as Yesso), and added a number of species to those he had previously obtained there, a list of which was given in my paper on his Japanese Mammals\*.

The result of the present important collection is to show that the two islands are exceedingly closely allied in their small mammal faunæ. For nearly all the same species are represented in both, although in the case of the *Sciurus*, *Micromys speciosus*, and *Krotomys* a slight difference, here considered of subspecific value, is perceptible. The Saghalien species (apart from Bats) as yet unrecorded from Hokkaido—*Sorex daphænodon* and *minutus*, *Sciuropterus russicus*, and *Sicista caudata*—will probably yet turn up in the more southern island. But the one Hokkaido species absent from Saghalien, *Micromys geisha*, is so common and so easily caught when present, that we may take it for granted that it really does not occur in the latter island. Moreover, it should be noted that the form of *M. speciosus* which occurs in Saghalien is allied to the Korean *peninsula*, while that of Hokkaido is nearer to the typical form found in Japan; so that in this genus, and this genus only, Hokkaido would seem to be more allied to Hondo than to Saghalien, a result probably due to the comparatively recent immigration of the species concerned.

The forms found in each island are as follows:—

#### Saghalien.

*Myotis mystacinus*.

*Sorex unguiculatus*, *daphænodon*, *shinto sœvus*,  
*minutus*, *gracillimus*.

*Sciuropterus russicus athene*.

*Sciurus vulgaris rupestris*.

*Tamias asiaticus*.

*Mus norvegicus*.

\* P. Z. S. 1905, ii. p. 333.

*Micromys speciosus giliacus.*

*Craseomys bedfordiae.*

*Evotomys umurensis.*

*Sicista caudata.*

*Lepus timidus.*

Hokkaido.

*Rhinolophus ferrum-equinum nippon, cornutus.*

*Plecotus auritus.*

*Sorex unguiculatus, shinto scervus.*

*Sciurus vulgaris orientis.*

*Tantias "lineatus."*

*Mus norvegicus.*

*Micromys speciosus ainu, geisha hokkaidi.*

*Craseomys bedfordiae.*

*Evotomys mikado.*

*Lepus timidus ainu.*

The present collection consists of 341 specimens, belonging to 22 species and subspecies, about half coming from each of the two islands referred to.

Of previous publications on the subject, reference need only be made to the following work :—

NIKOLSKY, A. M.—Survey of Saghalien and its Fauna.—Vertebrate Animals. St. Petersburg, 1889.

35 mammals are recorded, but they are mostly large species, of which Mr. Anderson was unable to obtain any examples.

The following are some extracts from Mr. Anderson's notes. It may be observed that he was the first person, not a Japanese, to enter the island of Saghalien after the cession of its southern portion to Japan.

"The island of Saghalien has a length of nearly 600 miles by at most 120 miles in breadth. In the north it is separated from the mainland by a shallow strait only 5 miles in breadth, while its southernmost point is 25 miles from the northern part of Hokkaido.

"Its two southern peninsulas are the continuations of mountain ranges leading up into the centre of the island, where they approach each other, but do not join. Korsakoff, the capital, is situated at the head of the gulf between the peninsulas.

"Both mountain ranges of southern Saghalien and the uncultivated parts of the valley are densely forested with coniferous trees (chiefly larch and fir), among which are mixed large numbers of birches, alders, and elms. The flora, indeed, is strikingly like that of Hokkaido. Heavy dews and frequent rains keep the soil constantly moist.

"My first collecting place (July 11th to 25th) lay 15 miles N.W. of Korsakoff, on the bank of a river which, draining a portion of the main range, empties into Aniwa Bay at its N.W. edge. Here

we were in the level valley, forested at this spot chiefly with larch, but, in such clearings as existed, growing rank with many herbs.

"From July 25th to August 5th I spent at a point some 7 miles up the same river. Here we were at the foot of the mountains of the main range, but we found few mammals on the forested hills. The best collecting was in the clearings, and open spots in the forest where grass, reeds, and 'weeds' grow rank.

"August 10th I began work at Dariné, and remained there till August 28th. Dariné is 25 miles N.W. of Korsakoff, and stands in the valley at the edge of the western mountains. Here, as elsewhere, we found both forest and clearings.

"I spent two days in the mountains west of Dariné, at an altitude of 1000 feet. Here the musk-deer is said to be plentiful, but I saw no evidence of it besides some scraps of skin and a long tooth shown me by a Japanese settler. The single chipmunk (*Tamias*) and other specimens were secured at this place, but these are all found in the lowlands as well.

#### *Notes on places visited in Hokkaido.*

"From Sept. 7th to Sept. 21st I worked at Ochiai, a village in nearly the exact centre of Hokkaido. This place is at an altitude of 1300 feet, and situated on a tributary of the Ishikari River, a little west of the crest of mountains that run from south to north through Hokkaido. The region is of steep though not lofty mountains, well covered with their native forest, which is largely coniferous in character. During my stay the weather proved pleasant, but chilly. This is said to be the coldest part of the island in winter.

"I spent the time from Sept. 24th to Oct. 6th at Kuchan, best described as 30 miles S.W. of Sapporo. This place is at the foot of a mountain called Shiribeshiyama, an extinct volcano closely resembling Fujiyama, though not so high. My collecting was done in the forest of oaks, chestnuts, maples, and elms that covers the foot of this mountain and the neighbouring hills. Altitude 900 feet or below."

#### 1. *RHINOLOPHUS FERRUM-EQUINUM* NIPPON Temm.

♂. 1113. Kuchan, 30 miles S.W. of Sapporo, Hokkaido.

#### 2. *RHINOLOPHUS CORNUTUS* Temm.

♂. 1118. Kuchan, Hokkaido.

The occurrence of these two species of *Rhinolophus* appears to be the most northern record of any Leaf-nosed Bat in the East, but in the warmer West, of course, they range considerably further north.

#### 3. *PLECOTUS AURITUS* L.

♂. 1028. ♀. 1027. Ochiai, Central Hokkaido.

Although the Long-eared Bat has often been said to occur in

Japan, these are the first examples from the Far East that the British Museum has received. They show remarkably little difference from European examples.

4. *MYOTIS MYSTACINUS* Leisl.

♂. 875, 880. ♀. 874, 876. 17 miles N.W. of Korsakoff, Saghalien.

♂. 923. ♂. 951. Dariné, 25 miles N. of Korsakoff.

5. *SOREX UNGUICULATUS* Dobs.

♂. 816, 877, 878. ♀. 817. 17 miles N.W. of Korsakoff, Saghalien. 150'.

♂. 946. Mountains 35 miles N.W. of Korsakoff. 1000'.

♂. 959. ♀. 899, 915, 950. Dariné, 25 miles N.W. of Korsakoff. 200'.

♂. 961, 1026. ♀. 960, 990, 1031, 1032, 1047, 1056. Ochiai, Central Hokkaido. 1200'.

♂. 1097, 1111. Kuchan, 30 miles S.W. of Sapporo, Hokkaido.

This large-footed Shrew was discovered in Saghalien by Dr. L. von Schrenk, by whom the type, afterwards described by Dobson, was sent to the St. Petersburg Museum. No example of it had hitherto reached the British Museum.

No. 899, a female, is smaller than usual, with a smaller skull, shorter tail, and lighter claws; but I can find no sufficient reason for distinguishing it from other specimens taken at the same place. Mr. Anderson notes of this individual that it "contained 5 embryos, 9.5 mm. long; mammae 6 in number, all inguinal."

6. *SOREX DAPHNODON*, sp. n.

♀. 916, 925, 956. Dariné, 25 miles N.W. of Korsakoff, Saghalien.

*S. araneus* group. The teeth very heavily pigmented; tail thickly haired.

Size and general characters of *S. araneus*. Hairs of back about  $4\frac{1}{2}$  mm. in length (summer specimens). General colour above dark brown (between Prout's brown and bistre). Sides little lighter than back; under surface dull greyish, with slight drabby tinge. Hands rather heavy, though not nearly so large as in *S. unguiculatus*, the claws slightly longer than usual; upper surface of hands and feet grey-brown, darker than in *S. annexus*. Tail of medium length, heavily haired and pencilled even in summer specimens; the hairs at the tip over 7 mm. in length.

Skull and dentition very much as in *S. araneus*, except that the teeth are extraordinarily heavily pigmented throughout, the pigment covering all the cones of the teeth and passing lower into the valleys than in any *Sorex* known to me; the hypocones of the upper  $p^1$ ,  $m^1$ , and  $m^2$  all heavily pigmented; viewed externally the limiting line of the brown pigment is more than halfway down the outer side of the teeth.

Dimensions of the type, measured in the flesh :—

Head and body 59 mm.; tail 38; hind foot (s. u.) 12·5; ear 8.

Skull—condylo-basal length 18·5 mm.; basal length 15·7; greatest breadth 9·6; greatest breadth across molars 5; vertical height from basion 5·9; front of i<sup>1</sup> to back of m<sup>3</sup> 8·2.

*Type.* Adult female. B.M. No. 7.2.5.16. Original number 916. Collected 17th August, 1906.

This Shrew is distinguishable from all other Eastern species known to me by its heavily pigmented teeth. In general appearance it is very like *S. annexus* Thos., but besides the difference in the teeth, its more hairy tail and differently coloured teeth at once distinguish it.

I owe to the kindness of Dr. Allen examples representing his *S. buxtoni*, described from Gichika Ochotsk Sea, and find that it has a smaller and slenderer skull (greatest breadth in type 8 mm.) and that its teeth are not more heavily pigmented than usual.

#### 7. *SOREX SHINTO SÆVUS*, subsp. n.

♂. 787, 850. 15 & 17 miles N.W. of Korsakoff, Saghalien.

♂. 948. ♀. 947. Dariné, 25 miles N.W. of Korsakoff.

♂. 1030, 1064. ♀. 995, 1050. Ochiai, Central Hokkaido.

♂. 1112. ♀. 1096. Kuchan, 30 miles S.W. of Sapporo, Hokkaido.

Quite like the true *S. shinto* Thos., of Hondo, in all respects, but larger throughout, except that the tail is only of about the same length.

The following are the external dimensions of four specimens, measured in the flesh :—

		Head & body.	Tail.	Hind foot.	Ear.
		mm.	mm.	mm.	mm.
Saghalien.	♂. 787 (Type).	69	50	12·5	8
"	♀. 947 .....	58	48	12·5	8
Hokkaido.	♂. 1112 .....	62	49	13	8
"	♀. 995 .....	58	50	12·5	8

Skull (of type)—greatest length 18·6 mm.; basal length 16·3; greatest breadth 9·2; length of upper tooth-series 7·8.

*Hab.* Both Saghalien and Hokkaido. Type from 15 miles N.W. of Korsakoff, Saghalien.

*Type.* Old male. B.M. No. 7.2.5.19. Original number 787. Collected 15th July, 1906.

This Shrew is evidently of the same type as the Hondo *S. shinto*, discovered previously by Mr. Anderson, but differs, as most northern forms so often do, by having a larger body, with a proportionally shorter tail. I can find no difference whatever between the Saghalien and Hokkaido specimens.

#### 8. *SOREX MINUTUS GRACILLIMUS*, subsp. n.

♀. 921. Dariné, 25 miles N.W. of Korsakoff, Saghalien. 200'. 18th August, 1906. B.M. No. 7.2.5.23. *Type.*

Size and proportions as in the smaller forms of European *minutus*. Skull very light and delicate, peculiarly narrowed in the facial region. In ordinary *minutus* the skull narrows evenly forward from the brain-case, but in *gracillimus*, while the brain-case is of about the usual breadth, the narrowing is much more abrupt in the interorbital region and the whole face in front of this is particularly light and slender. P<sup>4</sup> and molars rather narrower than in true *minutus*. Pigmentation of teeth slight, but the specimen is old, and they are all somewhat worn.

Dimensions of the type, measured in the flesh:—

Head and body 51 mm.; tail 44; hind foot 11; ear 6.

Skull—condylo-basal length 15.2 mm.; basal length 13.8; greatest breadth 7.7; interorbital breadth at hinder end of ante-orbital foramina 2.8; length of upper tooth-row 6.8; breadth across molars 3.4.

*Hab. & Type* as above.

Of this tiny Shrew, the Eastern representative of our Pygmy Shrew, Mr. Anderson only sent the skull and one hind foot, the rest having been stolen by a rat. Fortunately the measurements were preserved, and as these and the skull are the chief basis for systematic work on Shrews, the colours being comparatively unimportant, I have thought myself justified in giving a name to the animal on the very perceptible difference in the shape of the skull. No Far-Eastern forms of this group have been previously recorded, except under the old names of *S. minutus* or *pygmaeus*.

#### 9. *SCIUROPTERUS RUSSICUS* \* *ATHENE*, subsp. n.

♀. 865. 17 miles N.W. of Korsakoff, Saghalien, 1st August, 1906. B.M. No. 7.2.5.24. *Type*.

Colour as in *S. momonga*†; skull as in true *russicus*.

General colour above drab-grey, the tips of the hairs clay-colour; under surface dull whitish, the sides slightly washed with reddish brown. Upper surface of hands and feet smoky grey, becoming black on the digits; the hairs at the bases of the claws clay-colour; hairy part of soles greyish white; lower side of digits naked. Tail very much as in *S. momonga*, the upper and under layers of hair black, the middle layer isabella or clay colour, the hairs at the tip verging towards buffy.

Skull with the long palatal foramina and large bullæ of *S. russicus*, each of these parts being markedly smaller in *S. momonga*.

\* *Pteromys russicus* Tiedem. Zool. p. 451, 1808. American zoologists have rightly shown that the name *volans* Linn. belongs to the American species; but this is not because Linneus's *Mus volans* is founded on Seba's Pl. xlv. fig. 3, "exclusively American," as the animal figured by Seba is clearly a *Petaurista*, in spite of his statement that its locality was Virginia. The real basis of the Linnean name is Ray's *Sciurus americanus volans* (Quadr. p. 215, 1693), which is undoubtedly the American species.

† Or at least as in *S. momonga amygdali* Thos., the restricted *momonga* being only represented by a bleached specimen.



Dimensions of the type (immature):—

Head and body 125 mm.; tail 110; hind foot 36.5; ear 20.5.

Skull—greatest length 37 mm.; basilar length 28; zygomatic breadth 22; interorbital breadth 7; palatilar length 16.2; palatal foramina 4.8; length of bullæ 10.1; length of upper tooth-series 7.2.

*Hab. & Type* as above.

This Flying-Squirrel seems to be a local race of the Russian and Siberian *S. russicus*, rather than any relation of *S. momonga*, though its colour is exactly as in the latter, instead of the clearer grey of its ally. Satunin's *S. buchneri*\*, from Kansu, has a shorter hind foot and a more rufous colour.

10. *SCIURUS VULGARIS RUPESTRIS* †, subsp. n.

♀. 812. 15 miles N.W. of Korsakoff, Saghalien. Sea-level.

♂. 927. ♀. 952-958. Dariné, 25 miles N.W. of Korsakoff. 200'.

♂. 944. ♀. 945. Mts. 35 miles N.W. of Korsakoff. 300' & 1000'.

Quite like *S. v. orientis*, in summer pelage, but markedly smaller throughout. Winter pelage not represented.

Colour in summer as in *orientis*, but there appears to be a greater proportion of melanism, for not one of the six specimens is unaffected in this way. The least affected (No. 927, the type) has the feet and flanks blackish, while the only one (No. 812) which has the feet and flanks reddish, has the back of a very darker colour. The back of the type is rather redder than "Prout's brown."

Skull decidedly smaller than in *orientis*, 3-4 mm. less in extreme length, and the three true molars about half a millimetre less in combined length. This last point is important, as several of the specimens are immature, so that their full size can only be gauged by their teeth.

Dimensions of the type (slightly immature):—

Head and body 190 mm.; tail 174; hind foot 55; ear 32.

Skull—greatest length 48.8 mm.; basilar length 37; length of true molar series 6.7.

Dimensions of No. 944, a fully adult male:—

Head and body 208 mm.; tail 178; hind foot 57; ear 32.

Skull—greatest length 50.7 mm.; basilar length 39.5; length of nasals 14.3; breadth of brain-case 24; palatilar length 22.5; combined length of p<sup>4</sup> and three true molars 8.9.

*Type*. Immature male. B.M. No. 7.2.5.26. Original number 927. Collected 20th August, 1906.

In a group where the main distinctions have been made on colour, it is somewhat embarrassing to have to deal with this

\* Ann. Mus. St. Pétersb. vii. 1902, p. 3 (1903).

† I am informed by Dr. Knud Andersen that Saghalien is a modification of a Chinese word meaning "cliff at (the mouth of) Amur."

Squirrel, which differs in size alone from its Hokkaido ally, but there seems no doubt that it ought to have a name. Possibly some colour character will be found when winter specimens are available for comparison.

11. *SCIURUS VULGARIS ORIENTIS* Thos.

♂. 1065, 1073. Ochiai, Central Hokkaido.

♂. 1077, 1103. ♀. 1075, 1110. Kuchan, Hokkaido.

12. *TAMIAS ASIATICUS* Gmel.

♀. 949 (immature). Mts. 35 miles N.W. of Korsakoff, Saghalien.

13. *TAMIAS* " *LINEATUS* Siebold."

♂. 1039, 1063. Ochiai, Central Hokkaido.

♀. 989, 1006, 1019, 1038, 1049, 1070, 1071, 1072. Kuchan, Hokkaido.

This fine series, representing the first mammal ever described from Japan, "*Myoxus lineatus*" Siebold\*, is of much value to us, but for want of more Siberian material I am unable to venture an opinion as to its specific or subspecific relationship to *T. asiaticus*. But if not identical, it is certainly very closely allied to the latter.

14. *MUS NORVEGICUS* Erxl.

♂. 811. 15 miles N.W. of Korsakoff, Saghalien.

15. *MICROMYS SPECIOSUS GILIACUS*, subsp. n.

54 specimens (mostly immature) from 15 miles N.W. of Korsakoff (sea-level), 17 miles N.W. of Korsakoff (150'), Dariné (200'), and mountains 35 miles N.W. of Korsakoff (1000').

Most closely allied to the Korean subspecies, *M. s. peninsulae*†, with which it agrees in the proportionally long and hairy tail, as compared with the Japanese forms, but distinguished by the ear being uniformly shorter. In the considerable number of *peninsulae* examined, the ear is measured by Mr. Anderson as 15, 15.5, or 16 mm., generally the last in adult specimens. In the Saghalien form, on the other hand, the great majority have the ear measured as 14 mm., some two or three only being labelled as 15.

The colour of the Saghalien specimens is rather darker than in those from Korea, but the former are all in summer and the latter in winter pelage, which may account for the difference.

The fur, in summer pelage, is not so distinctly spinous as it is in Japanese specimens, but there is a certain crispness which may develop into spininess in old age.

\* Spic. Faun. Japon., in Diss. Hist. Nat. Japon. p. 13, 1824.

† P. Z. S. 1906, p. 662.

## Detailed measurements:—

	Head and body. mm.	Tail. mm.	Hind foot. mm.	Ear. mm.
♂. 881 (Type).	104	110	24	14·5
♂. 890 .....	104	111	24	14
♀. 882 .....	103	113	23·5	14
♀. 891 .....	102	108	22	15

Skull of type—greatest length 28 mm.; basilar length 21·8; zygomatic breadth 13·7; interorbital breadth 4·6; palate length 13·1; diastema 9; palatal foramina 5·7; length of upper molar series 3·7.

*Type.* Adult male. B.M. No. 7.2.5.42. Original number 881. Collected at Dariné, 11th August, 1906.

This is no doubt the "*Mus sylvaticus*" of Nikolsky's work, and indeed it is probable that all the Long-tailed Field Mice that have been recorded from the Far East of Asia belong to this or some closely allied form, with 2—2=8 mammae, and that none of them are really members of the *M. sylvaticus* group, with 1—2=6 mammae.

The following is a short synopsis of the Japanese and Korean forms of *Micromys*, which have been referred to or described in the present series of papers:—

A. Size large. Hind foot (s. u.) over 21 mm. and skull over 25. Supraorbital edges ridged.

a. Back not lined

*M. speciosus.*

a<sup>2</sup>. Tail shorter than head and body.

a<sup>3</sup>. Foot large, 20–28 mm. in adults. Hokkaido

*M. s. ainu.*

b<sup>3</sup>. Foot medium, 22–24 mm. in adults.

a<sup>4</sup>. Tail generally over 100 mm. Hondo &c.

*M. s. speciosus.*

b<sup>4</sup>. Tail 90 mm. or less. Oki Is.

*M. s. navigator.*

b<sup>2</sup>. Tail longer than head and body.

c<sup>3</sup>. Ears longer, 15–16 mm. Korea

*M. s. peninsulae.*

d<sup>3</sup>. Ears shorter, 14–15 mm. Saghalien

*M. s. giliacus.*

b. Back with a more or less distinct median line.  
Korea

*M. agrarius.*

B. Size smaller. Hind foot under 21 mm. and skull under 25. Supraorbital edges rounded

*M. geisha.*

c. Ears smaller, averaging about 13 mm. Saghalien

*M. g. hokkaidi.*

d. Ears larger, generally about 14 mm.

c<sup>2</sup>. Size larger, tail longer. Head and body 85–95 mm.

Tail 90–100 mm.

e<sup>3</sup>. Hind foot shorter, 18–20 mm. Hondo &c.

*M. g. geisha.*

f<sup>3</sup>. Hind foot longer, 20–21 mm. Yakushima

*M. g. yakui.*

d<sup>2</sup>. Size smaller, tail shorter. Head and body about 80 mm. Tail 80 mm. Oki Is. . . . .

*M. g. celatus.*

16. *MICROMYS SPECIOSUS AINU* Thos.

18 from Ochiai, Central Hokkaido, and Kuchan, 30 miles S.W. of Sapporo.

17. *MICROMYS GEISHA HOKKAIDI* Thos.

51 from Ochiai and Kuchan, Hokkaido.

18. *CRASEOMYS BEDFORDIÆ* THOS.

33 from all the localities visited in Saghalien.

19 from Ochiai, Central Hokkaido. 1200'.

♂. 1090. ♀. 1076. Kuchan, 30 miles S.W. of Sapporo, Hokkaido.

I can find no appreciable difference between the Saghalien and Hokkaido specimens of *Craseomys*.19. *EVOTOMYS AMURENSIS* Schrenk.

59 specimens from Saghalien (all localities visited).

The type specimen of this species was obtained by Schrenk close to the mouth of the Amur, and I have no doubt that the present series are referable to the same form. It is probably the "*Arvicola rutilus*" of Nikolsky.

From *E. mikado*, of Hokkaido, Schrenk's species is distinguishable by having the pale lateral area rising up much higher over the shoulders, so as to narrow the reddish upper colour to an ill-defined band little more than half an inch broad along the nape and withers. In *E. mikado* the shoulder area is rarely lighter or higher than the general light lateral colour. In addition the skull, or at least the brain-case, of *mikado* seems to average rather longer and narrower than in *amurensis*, though the difference is not very great, and the two forms are no doubt very closely allied.

20. *EVOTOMYS MIKADO* THOS.

29 from Ochiai, Central Hokkaido. 1200'.

21. *SICISTA CAUDATA*, sp. n.♀. 862. 17 miles N.W. of Korsakoff, Saghalien. 150'. 1st August, 1906. B.M. No. 7.2.5.104. *Type*."Among tall grass."—*M. P. A.*

A species without dorsal stripe, and with a very long brown unicolor tail.

Size rather larger than in *S. concolor* Büchn. Fur close and fine; hairs of back, in a summer specimen, about 6 mm. in length. General colour along the dorsal area pale brown, of a rather warmer tone than Ridgway's "wood-brown," the sides paler and with a slight buffy suffusion. Under surface pale greyish with a drab suffusion, line of demarcation on sides not strongly marked. Visible part of ears (proectote and metentote) well-haired, dark brown. Upper surface of hands silvery white, of feet similar except that the metatarsals are dusky mesially for their prominent third. Tail very long, well-haired, uniformly brown above and below. Mammæ 2—2=8.

Skull lightly built, smoothly rounded. A deep concavity present in the single specimen on the median frontal suture just behind the nasals; perhaps not normal. Palate very much as in *S. leathemi*, the edge of the mesopterygoid fossa close behind the raised ridge which runs across the palate between the last molars,

and distinctly in front of the anterior limit of the parapterygoid fossæ; the latter much narrower anteriorly than in *S. tianshanica*.

Dimensions of the type, measured in the flesh :—

Head and body 63 mm.; tail 115; hind foot 18; ear 14·5.

Skull—greatest length 20·7 mm.; basilar length 15·3; zygomatic breadth 10·6; interorbital breadth 4; breadth of brain-case 10; palatilar length 8·5; palatal foramina 4·1; length of upper cheek-tooth series (crowns) 2·7.

*Hab. & Type* as above.

The discovery of the genus *Sicista* in Saghalien is a considerable extension of its known range, as the furthest eastern point from which it appears to have been recorded is Kan-su, W. China.

*Sicista caudata* seems to be most nearly allied to *S. concolor* Büchn. from Kan-su, as *S. subtilis* is at once distinguishable by its dorsal stripe and elongated palate, and *S. leathemi* Thos. and *tianshanica* Salensky by their bicolor tails. From *S. concolor* it may be separated by its longer tail and shorter tooth-series, while other differences will no doubt be found when examples of the two forms can be directly compared.

## 22. *LEPUS TIMIDUS* L.

♂ (young). 924. Dariné, 25 miles N.W. of Korsakoff, Saghalien.

On the Cold-blooded Vertebrata of Saghalien.

By G. A. BOULENGER, F.R.S.

One Lizard, *Lacerta vivipara*, one Snake, *Vipera berus*, and one Frog, *Rana temporaria*, species existing over the whole of Northern Europe and Asia, were the only known representatives of the Reptiles and Batrachians hitherto recorded from Saghalien\*.

The collection made on the island, 15–25 miles N.W. of Korsakoff, by Mr. Malcolm P. Anderson in July and August 1906, and presented to the British Museum by His Grace the Duke of Bedford, includes several examples of the Common Lizard, and representatives of the following species :—

*Tropidonotus vibakari* Boie.—Manchuria, Japan.

*Ancistrodon blomhoffi* Boie.—E. Siberia, China, Japan.

*Rana amurensis* Blgr.—Manchuria, N. China.

*Rana esculenta* L., var. *chinensis* Osb.—Corea to Siam, Japan.

*Bufo vulgaris* Laur.—Europe and N.W. Africa to Manchuria, China, and Japan.

*Bombinator orientalis* Blgr.—Manchuria, N. China.

The single fish collected by Mr. Anderson is referable to *Gastrosteus steindachneri* Jordan & Snyder.

\* Cf. A. M. Nikolsky's work (in Russian) on the Vertebrates of Saghalien, (St. Petersburg, 1899).

3. On some new Species of Earthworms of the Family *Eudrilidæ*, belonging to the Genera *Polytoreutus*, *Neumanniella*, and *Eminoscolex*, from Mt. Ruwenzori. By FRANK E. BEDDARD, M.A., F.R.S.

[Received April 9, 1907.]

(Text-figures 122-127.)

The following pages relate to a number of species of Eudrilidæ which I received from the Natural History Museum through the kindness of Mr. W. R. Ogilvie-Grant, F.Z.S. They were collected upon Mt. Ruwenzori along with a number of other species of Oligochaeta belonging to the genera *Benhamia* and *Alma*. These latter genera have been lately investigated by Signor Cognetti de Martiis\*, upon material collected by H.R.H. the Duke of the Abruzzi from the same locality. I have therefore limited myself to the description of the Eudrilidæ, of which specimens must, I should presume, have been collected by the Italian expedition; but they have not, so far as I am aware, up to the present been described. All the species are new, but are referable to genera already defined, which genera are in every case East African in range.

***Polytoreutus ruwenzorii*, sp. n.**

Of this species the collection contained but a single example, and that in a not very good state of preservation for dissection. I have, however, been able to ascertain, as I think without doubt, that the species is new and allied to a small group of species of this genus of which all the members known hitherto have been described by Michaelsen†. This group—which includes the species *P. kirimaensis*, *P. usindjaensis*, and *P. sylvestris*—is limited to the shores of Victoria Nyanza, Albert Nyanza, and the neighbouring country; and the occurrence therefore of an ally upon Mt. Ruwenzori is not surprising. The likeness of these four forms is to be seen chiefly in the peculiar relations of the diverticula of the spermathecal pouch and, in three of them at any rate‡, in the existence of paired copulatory pouches debouching to the exterior on either side, and independent, of the penis. The present species, whose exact locality within this area I fix by means of its specific name, is represented by an example quite fully mature which measures 77 mm. in length by 5-6 mm. in breadth. It is therefore a stoutish but also shortish worm.

The setæ of *Polytoreutus ruwenzorii* are disposed like those of other species of the genus: i. e. the ventral setæ are much wider apart than the lateral setæ. The distance between each seta of the ventral pair is something like three times that which separates

\* Boll. Mus. Zool. Torino, vol. xxi. notes i. and iii.; vol. xxii. note xiv.

† "Regenwürmer," in Deutsch-Ost-Afrika, 1896.

‡ Apparently not in *P. usindjaensis*.

the individual setæ of the lateral pair. I have endeavoured to make an exact study of the distribution of the setæ upon the clitellar segments, concerning which there is some but not exhaustive information, of some other species of the genus already described; for this character seems to be one of probably systematic value. On these segments I could only find one of the two setæ of the lateral pair, and the seta present was the innermost. I ought to mention that these statements depend upon a microscopic examination of the entire cuticle stripped from the body, and not merely upon an inspection of the entire worm with a lens. The apertures through which the setæ are protruded are so obvious that the failure to find one is strong evidence of its absence. The ventral setæ, on the other hand, were present upon the clitellar segments with the exception of the xviith, where only the outer seta of the pair was present. Ventrally the clitellum is not so strongly developed as it is laterally and dorsally, which facts may be related to the presence or absence of setæ.

The *clitellum* of *Polytoreutus ruwenzorii* is, like that of *Polytoreutus sylvestris* and some, but not all, other species, best developed laterally and dorsally. Ventrally it is not so well developed, and here the intersegmental furrows are plainer than laterally. It embraces segments xiii. to xvii., which is the usual extent of the clitellum in this genus.

The *nephridiopores* lie in front of the lateral pair of setæ, in front of each pair, and not in front of any one seta of the pair more particularly. They commence apparently in the fourth segment. A notable fact with reference to these pores is that when the cuticle is stripped off—and I have mapped the pores by this means—a considerable strip of the (as it would therefore appear) chitinous lining of the duct of the nephridium is also stripped off and protrudes from each aperture. I have not noticed anything of this kind in other Oligochæta.

The *oviducal pores* are quite conspicuous and lie upon the xivth segment behind and to the outside of the nephridial row and the lateral seta of that segment. The single *male pore* is on the border of segments xvii./xviii. and the *spermathecal pore* behind it upon the interval xviii./xix.

The internal anatomy of this species, so far as concerns the alimentary and circulatory organs, seems to agree with that of the next species to be described and with the members of this genus generally.

The *sperm-sacs* are like those of *Polytoreutus* generally (but not *P. bettonianus*) in being exceedingly long, and at their commencement and for a long way back of much less diameter than they are more posteriorly. The sacs extend for more than 30 segments back from their point of origin. That of the right side is fifteen segments longer than the shorter sperm-sac of the left side. The difference in length in this species is more pronounced than in that next to be described. The dilated chambers at the beginning of the *sperm duct* immediately after it leaves the funnel are

conspicuous in this as in the next species. The *spermiducal glands* are peculiar in form and do not altogether agree with those of *P. sylvestris*, to which they appear to come nearer in structure than to those of other species of the genus *Polytoreutus*. They agree, however, with the last-named species in the fact that the duct of the gland instead of emerging, as is the rule among these worms, from the end of the spermiducal gland, leaves the gland some little way in front of the proximal end. Each gland is rather bent in form, but otherwise lies straight. It is of firm consistency, but is not covered with a sheath of muscle appreciable to the naked eye or through a lens. The slight bending of the corresponding glands in *Polytoreutus sylvestris* figured by Michaelsen is rather exaggerated in the present species. They appear also to be rather longer in *P. sylvestris* than in *P. ruwenzorii*. Michaelsen does not mention in that species a character which is very noteworthy in *P. ruwenzorii*. He describes the "prostate" glands indeed merely as being "unregelmässig eingeschnürte." In the specimen of *P. ruwenzorii* reported upon here the surface of the gland was much marked by furrows, and the appearance given was that of a very long gland tightly coiled up with some concrescence between the individual loops of the coil. There is no indication of anything of the kind in the figures given by Michaelsen either of *P. sylvestris* or of its allies. The two copulatory chambers mentioned by Michaelsen\* in *P. sylvestris* and *P. kirimaensis* are quite as large in *P. ruwenzorii* as in those species.

As in several species—for example, *Polytoreutus kirimaensis* †,—the present species of *Polytoreutus* is to be characterised by a very slender *spermathecal sac* which lies beneath the nerve-cord, than which it is no thicker. It is thus difficult to see, and, as Michaelsen has remarked, is apt to escape the eye. Particularly was this the case with the worm described in the present communication. For the contents were very slight in certain regions of the sac, which rendered it even more difficult of observation. It is certainly no wider than the nerve-cord, which overlies it. It is largely by virtue of the different forms which the spermathecal sac shows in this genus that the species of *Polytoreutus* are discriminated.

The species which I name *Polytoreutus ruwenzorii* is quite different in details, so far as concerns this organ, from any other species of which descriptions have been published. It comes nearest to *Polytoreutus* ‡ *kirimaensis* so far as I can gather, but shows obvious differences from that species.

The median spermathecal sac is slender as in that species and is straight or nearly so in its course beneath the nerve-cord, not much convoluted as in the allied *Polytoreutus sylvestris* §.

\* *Loc. cit.*

† Michaelsen, "Die Regenwürmer Ost-Afrikas," in *Deutsch-Ost-Afrika*, vol. iv. 1898, p. 16.

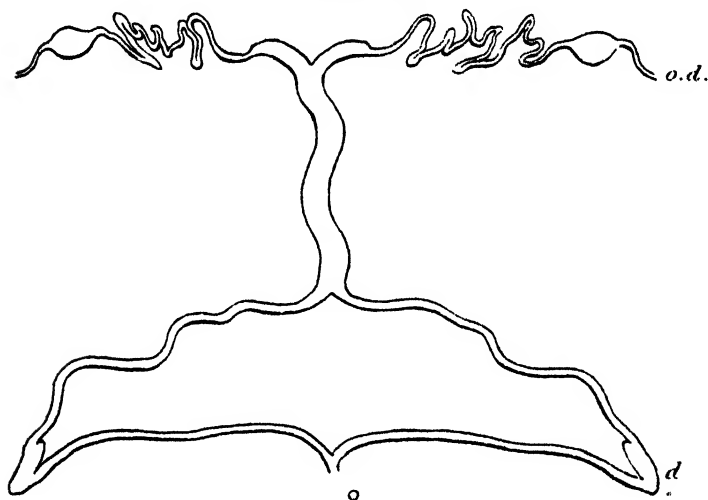
‡ *Loc. cit.* pl. ii. fig. 31.

§ Where, however, it is also occasionally less convoluted, perhaps in less mature individuals (Michaelsen, *loc. cit.* pl. ii. fig. 23).



Anteriorly the sac passes into the fourteenth segment near to the anterior wall of that segment without any change. Arrived here it ends in two diverticula of short extent: These diverticula are apparently of much shorter extent than in any of the species *Polytoreutus kirimaensis*, *P. usindjaensis*, and *P. sylvestris*, whose spermathecal apparatus is built upon the same plan as that of *P. ruwenzorii*. Michaelsen, as a matter of fact, does not differentiate, except in the case of *P. usindjaensis*, between each diverticulum and the oviduct with which it becomes continuous, which in fact opens into it according to my interpretation of these various structures in the genus *Polytoreutus* \*. In the figure annexed hereto this arrangement is rendered plain. The sudden diminution of the cæcum of

Text-fig. 122.

Spermathecal sac of *Polytoreutus ruwenzorii*.

d. Diverticulum of sac. o.d. Oviducal pore. ♀. Spermathecal pore.

the spermathecal sac (text-fig. 122) where it is continuous with the oviduct is obvious. Moreover, the oviduct is extremely long as compared with that of some other species, and is much coiled. Much more so is this the case with *Polytoreutus ruwenzorii* than with either of the three species mentioned as coming nearest to it in respect of the spermathecal sac and its forward diverticula. But apparently these three species do agree with *P. ruwenzorii* in having a much longer oviduct than in many other species of the genus. There is a further point of agreement between the new species described in the present paper and the three East-African species with which I have compared it in the nature of the

\* P. Z. S. 1902, vol. ii. p. 206 *et seq.*

spermathecal diverticula. The slender spermatheca just in front of the terminal section of the male efferent apparatus divides into two branches, which diverge at right angles and run dorsally, this portion of the spermatheca forming a tube more than 5 mm. in length. Towards the dorsal median line the tube of each side turns back upon itself after emitting a very short but slightly swollen diverticulum; the recurrent branch runs alongside of the outgoing branch, the two forming a loop which suggests at first sight a nephridium. It is indeed not very much thicker than the nephridia. The returning branch then, having arrived at the level of the point whence it departed, dorsally turns at right angles and joins its fellow a little in front of the external aperture, which is quite inconspicuous. This peculiar origin of the diverticulum on each side is exactly matched in the three species to which the present is evidently allied, viz. *Polytoreutus usindjaensis*, *P. kirimaensis*, and *P. sylvestris*. But in all of the three species mentioned the diverticulum itself is of some considerable calibre. *Polytoreutus kirimaensis* comes nearest to the present species in that the diverticulum is smaller than in the other two. But even in this species it is much larger than in *P. ruwenzorii*. There is thus no difficulty in discriminating *Polytoreutus ruwenzorii* by the structure of the female efferent and copulatory apparatus. It is very interesting to notice that *Polytoreutus ruwenzorii* also shows points of resemblance to *P. sylvestris* and *P. kirimaensis* (but apparently not to *P. usindjaensis*) in the structure of the male efferent apparatus, which has been already described. There seems to be no doubt that these four species form a little group of *Polytoreutus*; but it is not possible in my opinion to separate them off from the other species as a genus or even a subgenus, at least at present.

It is clear from the above account that *Polytoreutus ruwenzorii* comes nearest to *P. sylvestris* of Michaelsen. It is only, as I think, with this species that we have to reckon in determining the distinctness or otherwise of the *Polytoreutus* which I regard as new.

The most plain differences from this species are to be seen in the small size of the spermathecal diverticula and the very reduced length in front of the undivided portion of the posteriorly fused spermathecal sacs. It may be thus defined:—

### ***Polytoreutus ruwenzorii*.**

Length 70–80 mm.; breadth 4–5 mm. Distance between setæ of ventral pair three times that between setæ of lateral pair. Outer setæ of lateral pair absent on clitellar segments. Clitellum saddle-shaped. Male pore xvii./xviii.; spermathecal pore xviii./xix. No genital area behind pores. Spermathecal sac bifurcate for a short distance in front; posterior diverticula very small; oviduct between spermathecal sac and receptaculum very long. Right sperm-sac longer than left. Spermiducal glands giving off duct in front of proximal end gland, much furrowed. Copulatory chambers present.

***Polytoreutus granti*, sp. n.**

In describing some years since\* several species of this genus from East Africa, I found among a collection from Mt. Kenya two closely allied species, which, however, were plainly to be differentiated upon a careful study. It is interesting to find upon Ruwenzori the same presence of two closely allied species of *Polytoreutus*, not—it may be remarked—specially related to their congeners of Kenya. To find closely related species in the same comparatively restricted area is rather more remarkable than would have been the existence of more remotely allied examples of the same genus. This species, which I have named after Mr. Ogilvie-Grant, F.Z.S., comes nearer to *Polytoreutus kirimaensis* than does *P. ruwenzorii*. It is represented by a single specimen, not fully mature as to the clitellum, but apparently quite fully mature as to the sexual organs. One of the two copulatory chambers and the penis were protruded. The size and the external characters generally agree with those of *P. ruwenzorii*.

The worm is a trifle more slender. The *clitellum* was not developed, and upon the segments to be included in it I observed no deficiency of setæ such as occurs in *P. ruwenzorii*. The relations between the distances which separate the two setæ of each pair are much as in *P. ruwenzorii*. In the same way I observed a long tube of chitin to be extruded from the nephridiopores. I do not like to assert positively that there is a difference between the two species in the segment which contains the first pair of *nephridiopores*. But in the present species I noted a pair of these apertures in the third segment, *i. e.* a segment further forwards than I observed the same pores in *P. ruwenzorii*. The internal anatomy seems to agree with that of *P. ruwenzorii* and other species of *Polytoreutus* in the alimentary canal with its appended calciferous glands and in the situation of the last heart (eleventh segment). It may be mentioned, however, that *P. granti*, like *P. ruwenzorii*, has the dorsal vessel doubled in the twelfth segment. This doubling of the dorsal vessel is known in the genus *Polytoreutus*—for example, in *P. gregorianus*†.

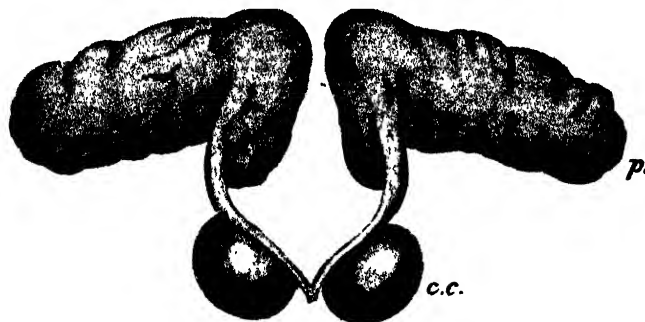
The *male organs of reproduction* are much like those of *P. ruwenzorii*, and yet show differences in minutiae. As in that and other species of the genus, there is but a single *vas deferens* on each side, ending in front in an elongated chamber ("Samen-magazine") behind the funnel. The *sperm-sacs* are but a single pair. They are elongated and not so markedly thin anteriorly as in *P. ruwenzorii* and other species. The right-hand sac, as in that species, is longer than the left, but the difference is not quite so pronounced. The length of the longer sac is 21 mm.

\* "On some new Species of Earthworms belonging to the Genus *Polytoreutus*, &c.," P. Z. S. 1902, vol. ii. p. 180.

† Beddard, P. Z. S. 1901, vol. i. p. 191. Michaelsen has not referred to the condition of the dorsal vessel in the species with which the present is particularly compared.

The two sacs are not joined at their distal extremity. The terminal apparatus of the male efferent ducts is quite like that of *P. ruwenzorii*. In precisely the same way (text-fig. 123) the *spermiducal gland* is almond-shaped, and somewhat bent upon itself at the point whence its duct emerges; the surface is not, however, quite so strongly furrowed. The copulatory chambers seem to be exactly as in *P. ruwenzorii*.

Text-fig. 123.

Terminal male organs of *Polytoreutus granti*.

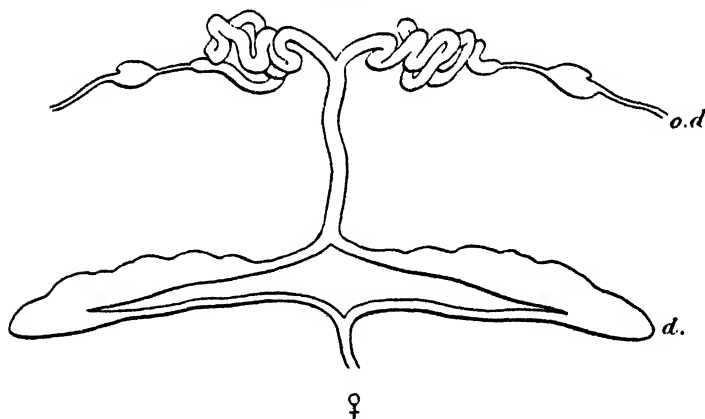
c.c. Copulatory chamber. p. Spermiducal gland.

The *female organs of generation* (text-fig. 124), on the other hand, show greater differences from the same organs in *P. ruwenzorii*. There is the same slender median *spermathecal sac* which underlies the nerve-cord and is hardly convoluted in its course. Nor is it of any greater diameter than the nerve-cord. Anteriorly this sac divides into two, but there is no marked division near to the point of bifurcation of the sac between the spermathecal sac and the oviduct which opens into it. This break is very clear in *P. ruwenzorii*. And in that species the diverticula\* of the spermathecal sac are short, the greater part of the coiled tube intervening between the unpaired spermathecal sac and the receptaculum being the oviduct. In the present species I could not ascertain the precise spot where the oviduct debouched into the diverticula of the spermathecal sac; but this point is at any rate very far removed from the point of bifurcation of the spermathecal sac; the greater part of the coiled tube, therefore, which intervenes between the unpaired spermathecal sac and the receptaculum being referable to the diverticula of the spermathecal sac. This important difference between these two species, otherwise very nearly allied, is remarkable. It is apparently correlated with another structural feature in which they differ. In examining

\* The word "diverticulum" is, of course, not strictly correct. The two spermathecae are fused in the middle and separate at both ends.

microscopically this part of the reproductive apparatus in glycerine after removal from the body, I noted in addition to the receptaculum, called by Michaelsen the "Eitrichterblase," a spherical chamber which obviously corresponds to what Michaelsen calls the "Ovarialblase," and which is believed by him to contain the ovary. In *Polytoreutus ceruleus*\* this Ovarialblase forms the end of the branch of the spermathecal sac into which it opens on the one hand, and is connected on the other with a narrow tube communicating with the Eitrichterblase, which is, I think, part of the funnel of the oviduct pulled out by the retreating spermathecal sac. I cannot be certain that the spherical chamber in *Polytoreutus granti* has the same connections, but I cannot help regarding it as the homologous structure. I have not represented it in the figure (text-fig. 124). Now this appears to be wanting in *Polytoreutus ruwenzorii* altogether, as it is, for example, in *Polytoreutus magilensis*. Where it does occur it appears to mark the boundary between the oviduct and the spermathecal sac; if so, then the present species has, as I have already suggested, a very long diverticulum to the spermathecal sac and a short oviduct†.

Text-fig. 124.

Spermathecal sac of *Polytoreutus granti*.

Lettering as in text-fig. 122.

*Polytoreutus granti* differs from its ally *P. ruwenzorii* in possessing, like *P. kirimaensis* and *P. sylvestris*, considerable appendages to the spermathecal sac posteriorly. These measured in my example 6 mm., and were therefore just a trifle shorter than the spermiducal glands, which measure 7 mm. in length. The proportions, in fact, are not very different from those of *P. sylvestris*; but in the present species the length of both structures

\* Michaelsen, JB. Hamb. wiss. Anst. ix. Taf. iv. fig. 80.

† Beddard, Quart. Journ. Micr. Sci. n. s. vol. xxxiv. pl. xxv. fig. 7.

seems to be considerably less than in *P. sylvestris*, where they extend very much further back in the body. As in that species, however, the spermathecal diverticulum on each side receives or emits the duct leading to the exterior from the side and not from the end. The relationships of the diverticulum to the thread-like regions of the spermathecal sac which enter and leave it were precisely like those depicted by Michaelsen for *P. sylvestris*, and not like those of *P. kirimaensis*; for in the latter species the spermathecal diverticulum simply bifurcates at its end into the incurrent and excurrent regions of the spermathecal sac.

The above account of the anatomy of *Polytoreutus granti* shows that it cannot be confused either with the species which I have just described or with any other known form. It comes nearest to *P. ruwenzorii* and to *P. sylvestris*. It differs most markedly from *P. ruwenzorii* by the characters of the spermathecal diverticula, and by the great length of the anterior undivided portion of the spermathecal sac. It differs from *P. sylvestris* mainly in the presence of a well-marked circular chamber at the end of the undivided spermathecal sacs, and by the shorter spermathecal diverticula and spermiducal gland. It may be thus defined :—

***Polytoreutus granti*.**

*Length* 70–80 mm.; *breadth* 4–5 mm. *Distance between setæ of ventral pair* three times that between setæ of lateral pair. *Male pore* xvii./xviii., *spermathecal pore* xviii./xix. *Spermathecal sacs* long and much coiled in undivided anterior region; *posterior diverticula* of some length. *Oviduct* between spermathecal sacs and *receptaculum ovarum* not long. *Right sperm-sac* longer than left. *Spermiducal glands* furrowed; *duct* arising before proximal end of *sac*. *Copulatory chambers* present.

***Neumannella ruwenzorii*, sp. n.**

I refer two fully mature, moderately large individuals, as well as a number of smaller specimens, of an earthworm, apparently new to zoology, to this genus *Neumannella*\*, for reasons which the following account of its structure will render plain. The principal distinguishing feature of the genus is thus described by its founder, viz.:—"Die für mehrere neue Arten aufgestellte Gattung *Neumannella* unterscheidet sich von den verwandten Gattungen *Eminoscolex*, *Gardullaria* und *Telendrilus* durch die vollständige Unpaarigkeit der Samentasche." This is plainly to be seen in *Neumannella ruwenzorii*. The larger of the two examples is 105 mm. long and measures 3 mm. in diameter. It is not strongly pigmented. The *prostomium* is very small and retracted within the peristomial segment.

The *setæ* have the usual arrangement met with in this genus. The individual *setæ* of the ventral pair are much wider apart

\* Michaelsen, "Die Oligochaeten Nordost-Afrikas," Zool. Jahrb. (Abth. f. Syst.) xviii. p. 501.

than the closely paired setæ of the lateral pair. The distance between each seta of the ventral pair is fully five times as great as that which separates the two setæ of the lateral pair. The setæ are rather small. On some segments, at any rate, of the clitellum there are no setæ present at all. This is certainly the case with segment xiv., where the exact position of the lateral seta between the nephridiopore in front and the ovipore behind could be easily fixed. There is no trace upon the cuticle (which was stripped off and examined) of these setæ or of the orifices through which they protrude. In *Neumanniella siphonochæta* Michaelsen particularly notes that setæ are present\* upon the clitellum. Nothing is said upon the matter in the case of other species. The absence of setæ upon the clitellum is well known to occur in certain species of *Pheretima*, while other species have them on the clitellum.

The *nephridiopores* are very plainly visible upon the clitellar segments only with the use of a lens; but they are not thus visible upon the other segments of the body. The reason for this is not wholly, if at all, the turgescence of the clitellar segments, which thus makes the pores obvious. When the cuticle is stripped off it is very distinctly to be noted that the pores themselves are smaller in size upon the preclitellar than upon the clitellar segments. The difference is very considerable. This can hardly be the result of stretching, and must indicate a larger nephridium, or, at least, a larger terminal duct to the nephridium. I observed the first nephridiopore upon the third segment. Michaelsen states (of the species † where he notes the point) that the nephridiopores lie in line with the pair of setæ *c d*. I found in *Neumanniella ruwenzorii* a decided relationship to seta *c*. These pores are, it should be added, near to the anterior dividing-line of their segment.

The *clitellum* of *Neumanniella ruwenzorii* is complete all round the body. It is as strongly developed upon the ventral as upon the dorsal side. Its yellow colour contrasts with the rest of the body. The clitellum shows some variation from species to species of this genus in the fact of being saddle-shaped or as in the present species. It begins upon the xiii<sup>th</sup> segment, the posterior one-third or so of which is invaded by the clitellar epithelium. At the other extremity it ends upon the xviii<sup>th</sup> segment, so that the dimensions are as in other species of the genus, and as in the Eudrilidæ generally. I have already remarked upon the apparent absence of setæ upon this region of the body; there are also no traces to be observed externally of penial setæ in the neighbourhood of the male generative pore or elsewhere.

The most anterior of the *generative pores* is the *spermathecal aperture*. This is very conspicuous in the middle line and just on the boundary-line of segments xiii. and xiv. It is rather a small orifice, but nevertheless quite evident. There is no modi-

\* *Loc. cit.* p. 502.

† *N. siphonochæta* and *N. tenuis*, *loc. cit.* pp. 502 & 505.

fication of the integument in its neighbourhood. On the xivth segment are the *paired orifices of the oviducts*. These lie exactly behind the nephridiopores of that segment and not far from the posterior boundary of the xivth segment. The apertures are quite conspicuous, but not much (if at all) larger than the nephridiopores upon the clitellum, which, as already mentioned, are wider than are those apertures upon the segments in front of the clitellum.

The *male pore* is a single aperture like the spermathecal pore. It lies exactly on the boundary-line of segments xvii. and xviii. It is considerably larger than the spermathecal pore, and the actual orifice is surrounded by an area having a rather transparent appearance. There is no protrusion of the Bursa propulsoria, nor is the orifice situated upon an area which is at all raised beyond the general level of the body. Apart from the slightly modified integument surrounding the male pore, which has no counterpart in the case of the spermathecal pore, the body of this species shows *no genital papillæ*.

With regard to internal structures I have no observations to make, save those based upon examination with a lens and a microscope in the case of detached pieces of certain organs and systems. I have not investigated this Eudrilid by means of sections on account of its poor state of preservation.

With regard to the alimentary tract, the paired calciferous glands seem to me to be rather further back than the thirteenth segment, but as the worm was much softened I should not like to be quite certain. The condition of the proximal swellings upon the sperm-ducts seems in this genus to offer systematic characters for the differentiation of the species. For in *N. tenuis* these "Samemmagazine" are hardly marked at all, and they are quite conspicuous in *N. siphonochæta*. In the present species these structures are present, but rather different in their condition from those of some other Eudrilidæ. Each of these swellings upon the sperm-duct is of oval form, tapering towards each end; but instead of lying immediately after the funnel of the sperm-duct, there is a considerable stretch of narrow tubular sperm-duct before the funnel. The latter lies deep within the sperm-sac. I have observed the characters of these bodies in the smaller specimens, not in that whose structure has served for the preparation of the rest of the present description of the species.

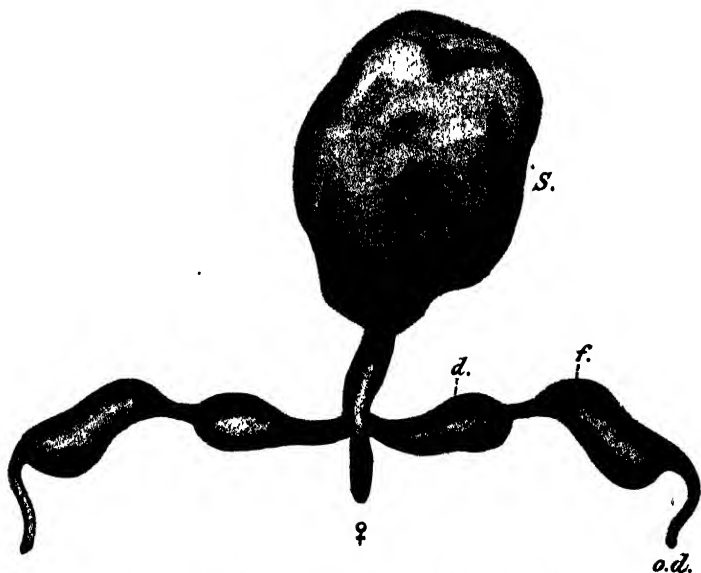
The *terminal male efferent apparatus* is constituted as follows:— Each of the two prostate or spermiducal glands measured about 10 mm. in length, and each gland was folded only once upon itself, thus forming a U. The diameter of each gland was not more than, if indeed quite so much as, 1 mm. The (morphologically) posterior end of each gland lay further forwards in the body than the proximal or anterior end of each spermiducal gland. Anteriorly each tubular spermiducal gland suddenly narrowed to form a firm and slender duct; the two ducts running backwards soon join and form an unpaired tube which constitutes



one limb of a U, the anteriorly directed limb being the *Bursa propulsoria*. The spermiducal glands have a soft opaque appearance; they are not hard and with a nacreous glitter as in some Eudrilids. On the other hand, the Bursa propulsoria has an almost metallic appearance to the naked eye. It is slender and fusiform. There are no penial setæ.

The *spermathecal gland* of this Eudrilid was unfortunately cut into when the animal was slit open along the back. It is more or less globular in shape, and occupies about the first half of the clitellum. It is quite dorsal in position, lying immediately beneath the body-wall, and has pushed the dorsal blood-vessel to the left. The contents were an opaque white granular mass, in which

Text-fig. 125.

Spermathecal apparatus of *Neumannella ruwenzorii*.

d. Diverticula of spermathecal sac (S). f. Funnel of oviduct. o.d. Oviducal pore.  
♀. Spermathecal pore.

could be detected nothing resembling a spermatophore, though the friable coagulated matter may have been the material out of which a spermatophore was to be constructed. The spermathecal sac (text-fig. 125), it should be said, widens out from its duct, which lies to the right side of the gut. I could see no indication of any communication between the spermathecal sac and the cavity of the intestine, such as occurs, for example, in *Parascolex*. The narrow duct of the spermathecal sac shows no nacreous glitter, nor does it ultimately widen out into any structure that may be termed a Bursa copulatrix. On the contrary, the duct of

the spermathecal sac just before its opening on to the exterior suddenly narrows to half its former calibre and becomes more muscular, with transverse and longitudinal fibres. At the point where this narrowing begins, two cæca, one on each side, are given off and slightly curled backwards. These arise therefore from what I have termed the duct of the spermatheca. These cæca are rather longer than the very narrow terminal chamber of the spermatheca, with a diameter half again the width of that chamber; each cæcum is about half the diameter of the wider part of the duct of the spermatheca. From the extremity of each cæcum arises a short tube with very weak muscular walls; this becomes a little wider, and at a short distance from the spermathecal cæcum contains the oviducal funnel, which can be seen to fan out within the chamber so formed. The oviduct apparently also opens partly into the receptaculum ovarum; the short oviduct opens on to the exterior in the usual way. The receptaculum ovarum was full of eggs. I could find no ovary within the chamber into which the funnel of the oviduct opens, and suspect that the ovarian tissue has been entirely transferred to the receptaculum ovarum. In any case, the various sacs and ducts mentioned appeared to form a closed system in which the ovary, if persistent elsewhere, was not included. I am not clear how far this species agrees and disagrees with others of the genus. In three of the four species described by Michaelsen, that naturalist figures a tube which encloses the oviducal funnel at one end and opens at the other into the spermathecal sac. There is no indication of any diverticula of the spermathecal sac which receives the "Verbindungsschlauch," such as I find in *Neumanniella ruwenzorii*. Nor could I, as already mentioned, detect a special ovarian sac lodging the ovary and communicating with the rest of the egg-conducting apparatus, such as Michaelsen found. It should be observed that this bifurcation of the spermathecal sac anteriorly to receive the oviducts is exactly like the disposition of this sac in *Polytoreutus*. Its presence in the species *Neumanniella ruwenzorii* necessitates a revision of the generic characters used by Michaelsen, who uses as a generic character the fact that "Samentasche ganz unpaarig." This character alone therefore serves to discriminate the present species from all of those described by Michaelsen. It may be thus defined:—

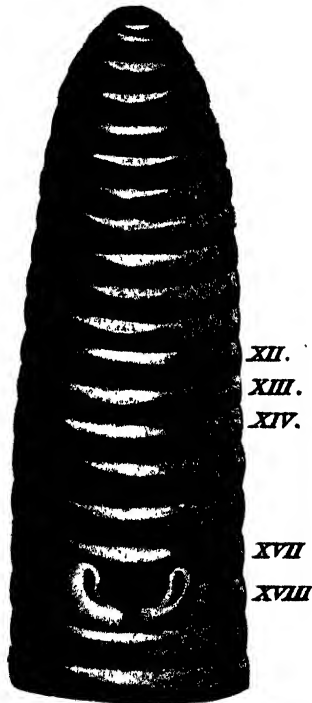
***Neumanniella ruwenzorii*.**

Length 105 mm., breadth 3 mm. Distance between ventral setæ about five times that between dorsal setæ. Some of the setæ absent from clitellum. Clitellum complete, xiii./xviii. Male pore single, median, upon xvii./xviii. Spermathecal pore single, median, upon xiii./xiv. Spermiducal glands with well-marked narrow long duct, each of which joins its fellow to open into fusiform muscular terminal chamber. No penial setæ. Spermathecal sac with two diverticula, which receive oviducts at extremities, and a small narrow muscular Bursa propulsoria.

***Eminoscolex ruwenzorii*, sp. n.**

I refer to a new species of the genus *Eminoscolex* a worm which is considerably softened, but in which the more important characters are nevertheless plainly visible. The completely paired condition of the male and female organs, coupled with the ventral calciferous pouches in segments ix., x., xi. and the paired glands in segment xiii., are decisive of its generic position.

Text-fig. 126.

Ventral view of *Eminoscolex ruwenzorii*.

Some of the segments are numbered.

The worm measures rather more than 200 mm. in length by 4-5 mm. in width, and is thus the largest species of the genus. The colour above is dark purplish brown. The clitellum was not developed. The *setae* are paired; but the phrase descriptive of these structures in Michaelsen's amended definition of the genus\*, viz., "Borsten ventral sehr weit, lateral enger gepaart," hardly applies to the present species.

\* "Die Oligochæten Nordost-Afrikas," Zool. Jahrb. (Abth. f. Syst.) Bd. xviii. p. 482.

The ventral setæ (text-fig. 126) are rather wide, much as in *Polytoreutus*, but the lateral setæ are only slightly more approximated, the proportions being about 5:6. It is remarkable that on the nine or ten anterior segments of the body the ventral setæ are very much larger, perhaps twice the size of the lateral setæ; this discrepancy ceases after that point, and both pairs of setæ are equisized and small. The ventral pair of setæ of the xviith segment are absent.

The *nephridiopores* lie in front of the lateral pair of setæ, and are not specially related to one or other of the pair. They appear to begin in the third segment.

The *oviducal pores* are upon the xivth segment, in line with the nephridiopores.

The *spermathecal pores* are paired as in other species of the genus. The pore of each side lies in front of the outer of the ventral pair of setæ. The pores are not very large.

On the following intersegmental furrow (*i. e.*, xiii./xiv.) are two pairs of minute orifices, which lie on a level with each of the four ventral setæ. They are rendered more conspicuous by being surrounded with a yellowish area. This area is the expression of internal sacs, which probably correspond to the copulatory glands found in many Earthworms of the families Megascolicidæ and Geoscolicidæ, but not, I believe, hitherto recorded among the Eudrilidæ. These sacs, though small, are very easily to be seen when the septum separating segments xiii. and xiv. is pushed forward.

The *male pores* are very large and conspicuous, and lie between segments xvii. and xviii. in a straight line with the spermathecal pores. The flaps of skin surrounding the pores cause them to be rather obliquely set, as is shown in the accompanying figure (text-fig. 126). The hinder margin of each orifice is much thickened and forms a glandular pad; the two very nearly meet in the middle line behind.

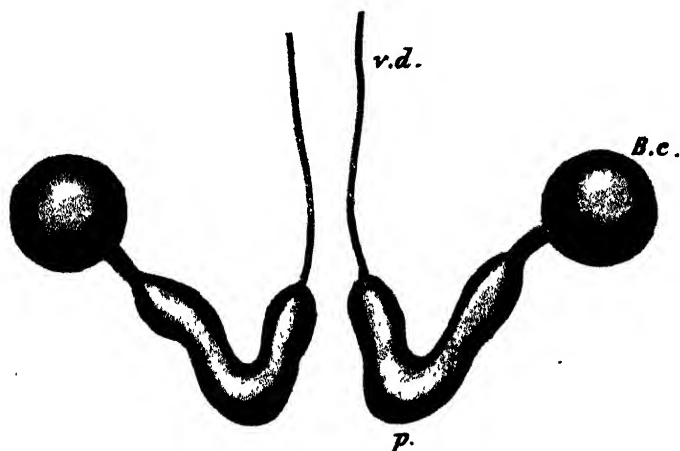
The intersegmental septa are not very much thickened, and they cease to be at all thickened after that which separates segments xi./xii. The gizzard, which is well developed, though not very large, lies undoubtedly in segment v. The median calciferous pouches are in segments ix., x., and xi. The paired calciferous glands of segment xiii. have rather an unusual form. Each consists of a relatively narrow tubular coiled structure very much longer than it is broad. This lies coiled on each side of the gut in the xiiiith segment.

The dorsal blood-vessel is nowhere double; the last pair of hearts is in segment xi.

The *male organs* are much like those of other species of this genus. The present species is holandrous, and the sperm-sacs are two pairs, more or less tongue-shaped bodies, in segments xi. and xii. The ends of the sperm-ducts near to where they open into the sperm-sacs are, as in other Eudrilidæ, dilated into what Michaelsen has termed a "Samenmagazin." As in other species

of *Eminoscolex*, the region of the sperm-ducts in question is not only widened but is of some length and coiled, forming a body of oval contour constituted by the closely approximated windings of the tube. It is conspicuous through its white colour as in other Eudrilidæ. The sperm-duct opens into the tip of the spermiducal gland (text-fig. 127), which is in this species directed forwards; the entire gland is sausage-shaped and bent once upon itself. It ends in a narrow muscular duct which opens into the rather large Bursa propulsoria; the latter is of circular contour. There are no penial setæ.

Text-fig. 127.

Terminal male organs of *Eminoscolex ruwenzorii*.

B.c. Bursa propulsoria. p. Spermiducal gland. v.d. Vas deferens.

The *female organs of generation* were so much softened that some details have probably escaped me. It is, however, plain that there are a pair of nearly spherical spermathecal sacs which are perfectly free from each other and do not communicate, as in some species of the genus, at the distal extremity with each other. The oviduct is very long and straight in its course; anteriorly it is seen to communicate with a rather small receptaculum ovarum, which lies close to the septum dividing the xiii<sup>th</sup> from the xiv<sup>th</sup> segment to the outside of the oviduct. In the other side is a slight swelling which appears to be fixed against the septum dividing the same segments, which doubtless represents the "Eitrichterblase" and the "Ovarialblase." I am doubtful whether this chamber is also in communication with the spermathecal sac or surrounds it. It is not, however, necessary to settle this point for purposes of the identification of the species, which I believe is sufficiently distinguished from other species of the genus hitherto described. Of these there are ten species known.

A peculiarity of *Eminoscolex ruwenzorii* is the thickened fold

which bounds the male pores posteriorly, and is comparable to a rudimentary penis or pair of penes. Of this structure there seem to be the equivalents in a few other species, viz. in *E. sylvestris* \*, *E. barnimi* †, *E. neumanni* ‡, *E. viridescens*, and perhaps *E. toreutus* §. Although the mere thickening which I have figured in *E. ruwenzorii* is different from the projecting penis of *E. viridescens*, the immaturity of my specimen might account for the difference very easily.

But *Eminoscolex ruwenzorii* is to be distinguished from *E. sylvestris* and *E. barnimi* by the fact that the dorsal setæ are further apart than in those species, where the distance *a-b* is three times the distance *c-d*. It cannot be confused with *E. neumanni* by reason of the fact that in the latter species the spermathecal pores are opposite to the lateral setæ, whereas in *E. ruwenzorii* they are, as in the majority of species, in front of the ventral setæ. There remain *E. toreutus* and *E. viridescens*. In the latter species ||, however, the spermathecal pores are a segment further back and are placed in a common depression; in *E. toreutus* the spermiducal glands appear to have a different form and the spermathecae are larger. *Eminoscolex ruwenzorii* may be thus defined:—

***Eminoscolex ruwenzorii*.**

Length 200 mm.; breadth 4–5 mm. Ventral setæ rather further apart than lateral, the proportions being 6 : 5. Ventral setæ of nine anterior segments enlarged. Male pores xvii./xviii., with thickened posterior margins (a penis?); female pores xii./xiii., in line with seta b. Copulatory-gland pores on xiii./xiv. Proximal ends of four sperm-ducts widened and twisted into a closely adpressed coil. Spermiducal gland of only moderate length, with narrow muscular duct. Spermathecae more or less spherical, not conjoined.

#### 4. Some Notes on Hybrid Bears.

By HENRY SCHERREN, F.Z.S.

[Received April 9, 1907.]

The fact that some months ago the Hon. Walter Rothschild purchased from Stuttgart and deposited in the Society's Gardens two hybrid Bears attracted attention to these animals, and induced me to look into the literature on the subject. Bears play a considerable part in folk-lore; and one might have imagined there would be many references to cases of hybridity, seeing that these animals have been credited with carrying off women. The following story is quoted by Gesner ¶ from Gillius:—

“De Philippo Cosseo Constantiensium sacris præfecto, ingenu-

\* Michaelsen, Zool. Jahrb. (Abth. f. Syst.) xviii. p. 496.

† Id. MT. Hamb. wiss. Anst. xvii.

‡ Id. *ibid.* xiv.

§ Id. “Regenwürmer,” in Deutsch-Ost-Afrika, p. 9.

|| Michaelsen, Oligochaeta in ‘Das Tierreich,’ Lief. 10 (Berlin, 1900), p. 407.

¶ ‘Historiæ Animalium,’ lib. I., p. 1068.

arum artium perstudioso, qui hoc ipsum se ex bono autore cognitum habere, mihi valde affirmavit: ursum accepi ex montibus Allobrogum puellam in speluncam rapuisse, eandemque venereo complexu et osculatione prosecutum fuisse: atque ex pomis agrestibus, quæ permulta quotidie in speluncam inferret maturiora studiose delegisse, eidemque edenda amatorie dedisse, ac nimirum cum ad cibi inquisitionem proficisceretur, ingenti saxo speluncam, ne puella exire posset, occludisse. Cum autem post longam inquisitionem parentes ursinum latibulum præterirent, suam peradolescentem animadvertisse, saxoque ægre depulso, eam recepisse."

Similar stories have been told from remote antiquity of the anthropoid apes, and among them cases of hybridity, though suspected, are not established. I am acquainted with no case of hybridity in Bears in a wild state, and with but few in zoological collections. Dr. Brandes has suggested that the absence of records of wild hybrids is due to the fact that the species occupy regions widely separated; and that the paucity of menagerie-bred hybrids may be accounted for by the fact that there is always the fear that putting two individuals in one cage may have bad results, since a fight between two adult bears is sure to terminate fatally for at least one of the combatants.

In an article in the 'English Cyclopædia' Broderip refers to a belief in hybrids between the dog and the bear; and says that an account of such a creature was given in the 'Histoires Prodigeuses extraites de Plusieurs Fameux Auteurs Grecs et Latins, sacrez et prophanes, divisées en Cinq Tomes, le premier par P. Boaistuau: Tome Premier. Paris, 1582.' That author illustrated his article with a figure of the animal, of which a copy is reproduced in the Cyclopædia. This animal (Broderip writes) the author states he saw in England in the reign of Elizabeth, but the probability is that he was deceived by the English bear-wards and dog-fighters of Elizabeth's time, and that some dog selected for its bear-like appearance in certain points, an appearance aided by cropping the ears and tail and other skilful artifices, was palmed upon him and upon others as a hybrid engendered between a dog and a bear. As Boaistuau's book is rare, I have transcribed the passage from the copy in the British Museum Library (ed. 1566, ch. xxix.):—

"Cest animal monstrueux, que tu vois figuré au commencement de ce chapitre, est engendré d'un Dogue d'Angleterre et d'un Ours: de sorte qu'il participe de l'une et de l'autre nature: Ce qui ne semblera estrange à ceux qui ont observé à Londres comme les Dogues et les Ours sont logez en de petits cachots, les uns aupres des autres: et quand ils sont en leurs chaleurs, ceux qui sont deputez pour les gouverner, enferment une Ourse et un Dogue ensemble, de sorte que pressez de leurs fureurs naturelles, ils convertissent leur cruauté en amour, et de telles conjunctions nayssent quelquefois des animaux semblables à cestuy, encore que

soit bien rarement : entre lesquels i'en ay observé deux, qu'on avoit donné à monseigneur le marquis de Trans : l'un desquels il fist present à monsieur le Conte d'Alphestan, ambassadeur de l'Empereur : l'autre qu'il a faict amener en France, sur lequel l'ay fait retirer cestuy au naturel, sans que le peintre y ait rien obmis."

The first well-established case of hybridity in Bears appears to have occurred in the Society's Gardens \*, between a Black Bear ♂ (*Ursus americanus*) and a European Brown Bear ♀ (*U. arctos*). Copulation was observed in May 1859, and on December 31st three cubs were born, "naked and blind, and about the size of a full-grown rat." One cub was carried by the dam in her mouth for a day or two; and as it disappeared it was supposed that she devoured it. At the age of five weeks the surviving cubs (♂, ♀) were "as large as a common rabbit. Their eyes began to open by this time; they were covered with a short thick fur, and were nearly black." This last observation is of some value, as it supports those of other authorities with regard to the coloration of the hybrid cubs following that of the male. Mr. Bartlett did not give the duration of life, but reference to the Occurrence Book shows that they died on Feb. 14, 1860.

The next case occurred in the Zoological Garden, Cologne, the male parent being a European Brown Bear (*U. arctos*) and the female a Grizzly Bear (*U. horribilis*). Prof. H. Alexander Pagenstecher, of Heidelberg, visited the Gardens in Paris, Lyons, and Cologne, and the following passage † occurs in his account of what he saw in the city last-named :—

"Von Raubthieren haben wir namentlich noch den Bärenzwinger, ausgezeichnet durch die jungen Bastarde vom gewöhnlichen braunen Bären und der grauen Bärin, welche in dem weiten Käfige trotz ihres gewaltigen Körpers mit solcher Schnelligkeit umherrannte, dass man von der eminenten Gefährlichkeit des Thieres in der Freiheit eine genügende Vorstellung zu erlangen vermochte."

There seems to be no doubt about the event, but particulars were not entered at the time in the records of the Garden. Dr. Wunderlich, in reply to my enquiries, regretted that he could add nothing to the foregoing account, and informed me that no one now in the Garden remembered the hybrids.

Hanover Zoological Garden is said to have been the scene of the third case, about which, however, some doubt exists. Dr. Theodore Kottnerus-Meyer, writing on Mammalian Hybrids ‡, says :—

"In den achtziger Jahren . . . besass der Hannoversche

\* A. D. Bartlett, P. Z. S. 1860, p. 130.

† 'Zoologischer Garten,' 1867, pp. 287, 288.

‡ 'Zoologischer Garten,' 1904, p. 61.



Garten auch eine Grislybärin (*U. ferax*) die in glücklichster Ehe mit einem Braunbären (*U. arctos*) lebte, und wiederholt von ihm mit Erfolg gedeckt wurde. Die Jungen glichen dem Vater und hatten ganz den Typus des Braunbären."

Dr. Schöff, who has been Director since 1893, can find no trace of these hybrids, but has kindly promised to make enquiries.

The hybrids now in the Society's Gardens were born in the Garden which formerly belonged to Herr Nill, who bred hybrids between Polar and Brown Bears since 1874. His original stock consisted of a Polar Bear ♂, about 3½ years old, and a Brown Bear ♀, a year younger. Having shown a friendly disposition to each other, playing as freely as they could through the bars, the experiment was made of putting them together, with the best results. In the summer of 1875 copulation was observed, and on January 9, 1876, two cubs were thrown, which were quite white. The colour, however, soon changed to a silver grey with a bluish tinge, and by the summer to dark brown with a similar tinge. There was no sign of the whitish neck- or nape-band, generally more or less noticeable in young Brown Bears; and by the end of the summer the coats were yellowish white. Two other cubs were born from the same parents on January 14, 1877, and the following report on them by Dr. Steudel and Herr E. v. Martens\* is worth quoting in full:—

"Die beiden halbjährigen sind gegenwärtig vorherrschend graubraun, doch etwas ungleichmässig, die Kehlelegend in ihrer ganzen Ausdehnung auffällig hell fast weisslich. Die beiden anderthalbjährigen sind viel heller, Rücken und Seiten isabellfarbig, ein dunkelbrauner Mittelstreifen, bei dem einen ziemlich breit über den ganzen Rücken sich erstreckend bei dem andern nur in vorderen Theil schwach angedeutet, Oberseite des Kopfes hellbraun, Unterseite des Kopfes und Rumpfes weisslich, alle vier Extremitäten noch ziemlich dunkelbraun."

Two other lots of cubs were born from the same parents; and then one of the female hybrids was paired with the Polar Bear (her sire), and produced in succession several litters of three-quarter blood Polar Bears. The old female Brown Bear was given a mate of her own species, and produced normal cubs. It was established that the half-blood Polars were fertile *inter se*, as were the females with a pure Brown male.

The original Polar Bear died in the summer of 1898, and the female Brown Bear, which had thrown more than fifty cubs, was shot when the Garden was closed in 1906. At that time the hybrids (Polar and Brown) now in the Society's Gardens were purchased. Both are females, one half- and the other three-quarter Polar. The half-blood was born in December 1893, and

\* 'Zoologischer Garten,' 1877, p. 402.

in December 1897 she threw the three-quarter blood cub to her own sire, the original Polar Bear, which it may be mentioned was obtained by von Heuglin's expedition.

In his last Guide (undated) to his little Garden, Herr Nill thus described the animals:—

“Während die Bastardmutter gelblichbraun mit helleren Abzeichen am Kopf und dunkleren auf dem Rücken und an den Füßen gefärbt ist, in den Körperformen aber noch zwischen Eis- und Braunbär steht, hat das dreiviertelblütige junge Tier vollständig die Gestalt und die Farbe des Eisbären angenommen und ist nur noch durch eine ganz hellbraune Schattierung längs des Rückens von einem solchen zu unterscheiden.”

Since then the young has grown darker, but were it possible to put her to a Polar Bear her cubs would probably be indistinguishable from those of the true *Ursus maritimus*. When I visited the pretty Garden at Halle-an-der-Saale last summer, the Director, Dr. Gustav Brandes, drew my attention to a cage containing a male Polar Bear and a female Brown Bear, and remarked that he had reason to believe they had produced young, which had been eaten by the dam. Early in February of this year he kindly informed me that cubs had been born, and the mother was caring for them. The animals were put together in 1902; copulation was observed in the summer of 1904, and at the close of the year the female withdrew into the inner compartment, remaining there for some days, but it was impossible to be certain that a birth had taken place, though the condition of the mammae rendered that probable. Pairing again took place in the summer of 1905, and there was the same uncertainty as to results. Dr. Brandes, however, assumes that in both cases cubs were born and eaten by the dam, whose instinct of fostering her young had not developed. In July 1906 pairing was observed, and on January 23, 1907, three white cubs were born. Lest I should unintentionally misrepresent Dr. Brandes' view I quote a passage from his letter textually:—“Mich freut es, dass ich wieder einmal meine Ansicht, dass sich das Brutpflegeinstinkt erst entwickeln muss, mal wieder glänzend bestätigt hat. Man kann sich keine bessere Mutter denken, und daher hat sie doch zweimal die Jungen gefressen.” By the end of February the dark dorsal stripe was present. These cubs will be kept under close observation, and photographed from time to time, in order to illustrate the colour-changes in the coat. For more than a year Dr. Brandes has kept a Korean female Black Bear (*Ursus torquatus*) with a pair of Sloth Bears (*Melursus ursinus*), and they have lived peaceably together, though no young have been produced.



# INDEX.

Acrobates, 233.  
 Acrodytes  
   *daulintii*, 328.  
 Acryllium  
   *culturinum*, 170.  
 Addax  
   *naso-maculatus*, 2.  
 Æpyornis, 231, 234.  
 Æpypryinnus  
   *rufescens*, 202, 203,  
   205, 206, 207, 208,  
   217, 222.  
 Ærocharis, 360.  
 Agathodes  
   *ostensalis*, 82.  
 Agrotora  
   *eudoxantha*, 78.  
   *flavibasalis*, 78.  
   *fumosa*, 78.  
   *pictalis*, 78.  
   *semipictalis*, 78.  
 Akodon  
   *caliginosus*, 142.  
 Alactaga, 232.  
 Alcelaphus  
   *bubalinus*, 2.  
   *caama*, 114.  
 Alestes  
   *imberi*, 307.  
 Alma, 415.  
 Amara, 323.  
 Amblysomus  
   *chrysellus*, 288.  
   *obtusirostris*, 288.  
 Amphibolurus  
   *barbatus*, 58.  
 Anguilla  
   *bengalensis*, 311.  
   *labiata*, 311.  
 Anguis, 37.  
 Anomalurus, 226, 229.  
 Antilocapra  
   *americana*, 114.  
 Arachnidium, 252, 255.

Arachnoidia, 252.  
   *ray-lankesteri*, 250,  
   251, 255, 257.  
 Archæopteryx, 232, 233,  
   234, 235, 236.  
 Archernis  
   *callixantha*, 86.  
   *eucosma*, 86.  
   *ignealis*, 86.  
 Arctogalidia  
   *trivirgata*, 198.  
 Arctomys  
   *marmotta*, 212.  
 Artamia, 353, 354, 357,  
   358, 359, 365, 366,  
   371.  
 Artamus, 353, 357, 358,  
   359, 365.  
   *leucogaster*, 362.  
 Arvicanthia  
   *dorsalis*, 294.  
 Arvicola  
   *rutilus*, 413.  
 Atherura  
   *africana*, 210.  
 Aulacodes  
   *acropetalis*, 76.  
   *bipunctalis*, 76, 87.  
   *diopsalis*, 76.  
   *goniophoralis*, 76.  
   *lunalis*, 76, 87.  
   *plicntalis*, 76.  
   *purpurealis*, 76, 87.  
   *trichoceralis*, 76.  
 Aulacorhamphus  
   *sulcatus*, 1.  
 Barbus  
   *brucii*, 309, 311.  
   *elephantis*, 310.  
   *cutania*, 306.  
   *holubi*, 309.  
   *inermis*, 310.  
   *kessleri*, 308.

Barbus  
   *natalensis*, 309.  
   *polylepis*, 308.  
   *rapax*, 307.  
   *sector*, 309, 311.  
   *trimaculatus*, 310.  
 Barentsia  
   *misakiensis*, 252.  
 Benhamia, 415.  
 Bettongia  
   *ogilbyi*, 205, 207.  
   *penicillata*, 205, 207.  
 Bitis  
   *arietans*, 51.  
   *gabonica*, 51.  
   *nasicornis*, 51.  
 Bocchoris  
   *adipalis*, 79.  
   *aurotinctialis*, 79.  
   *euphranoralis*, 79.  
   *invertalis*, 79.  
   *telphusalis*, 79.  
 Boeotarcha  
   *hyalinialis*, 86.  
   *limbata*, 86.  
 Bombinator, 327.  
   *orientalis*, 414.  
 Bos, 115.  
   *grunniens*, 304.  
 Botyodes  
   *asiaticus*, 81.  
   *flavibasalis*, 81.  
 Bradina  
   *glauconialis*, 77.  
   *impressalis*, 77.  
   *melanoperas*, 77.  
 Bramatherium, 114.  
 Bubalis  
   *caama*, 184.  
 Buchanga, 367.  
 Bufo, 335, 337.  
   *agua*, 336, 337, 348.  
   *marinus*, 336.  
   *vulgaris*, 414.

- Bullimus**  
*bagobus*, 141.  
**Buteo**  
*desertorum*, 171.  
**Calamachrous**  
*albipunctalis*, 86, 87.  
*tranquillalis*, 86.  
**Calamites**  
*cyanea*, 328.  
**Calliste**  
*fastuosa*, 143.  
**Calogale**  
*rutilus*, 6.  
**Calyptrorhynchus**  
*banksi*, 380.  
**Campopaga**, 361.  
**Campylognathus**, 225.  
**Canis**  
*anthus*, 173.  
*curvipalatus*, 403.  
**Capota**, 309, 310.  
**Capra**  
*megaceros*, 188.  
**Caprinia**  
*castanealis*, 80, 87.  
*conglobatalis*, 80.  
*felderi*, 80.  
*ocellalis*, 80, 87.  
**Capromys**  
*pilorides*, 208, 216.  
**Cephalophus**, 115.  
*coronatus*, 114.  
*grimmii*, 185, 298.  
*maxwelli*, 185.  
*natalensis*, 298.  
**Ceratophryne**  
*nasuta*, 327.  
**Ceratophrys**, 351, 352.  
*dorsata*, 331.  
*nasuta*, 324.  
*ornata*, 336, 347, 348.  
**Cercoleptes**  
*caudivolutus*, 198.  
**Cercopithecus**  
*albigularis*, 286.  
*campbelli*, 2.  
*denti*, 2.  
*mona*, 2.  
*pygerythrus erythrarchus*, 286.  
**Cervicapra**  
*arundinum*, 237, 299.  
— *occidentalis*, 237.  
*bokor*, 185, 186.  
**Cervus**  
*aristotelis*, 192, 193.  
*cashmiriensis*, 1.  
*elaphus*, 2, 114.  
*maral*, 1.  
*sika*, 192, 216, 219.  
**Chalcides**, 58, 59.  
*ocellatus*, 59.  
**Chalcidoptera**  
*emissalis*, 79.  
**Chamaeleolis**, 45–49, 53.  
**Chamaeleon**, 58, 67.  
*basiliscus*, 36, 39, 40, 44.  
*culcarifer*, 36, 37, 39, 41, 43, 44.  
*dilepis*, 36, 37, 39, 40, 41, 43, 44.  
*monachus*, 36, 37.  
*parvilobus*, 36, 37, 38, 39, 40, 41, 44.  
*pumilus*, 36, 39, 41, 42, 43, 44, 45, 68.  
*tamiohronchus*, 36, 41, 42, 43, 44, 68.  
*verrucosus*, 36, 37, 38, 40, 42, 44, 49.  
*vulgaris*, 36, 37, 41, 49.  
**Chlamydomorphus**, 198. \*  
**Chlamydosaurus**, 52.  
**Cirrhochrista**  
*etherialis*, 69.  
*caconalis*, 69.  
*figuratalis*, 69.  
*pulchellalis*, 69.  
**Clarias**  
*gariepinus*, 311.  
**Onaphalocrocis**  
*medinalis*, 79.  
**Cobus**  
*lechwe*, 237.  
*robertsi*, 237.  
*smithemanni*, 237.  
**Cælogenys**, 193.  
*paca*, 209, 216.  
**Coluber**  
*corais couperi*, 234.  
**Compsognathus**, 231.  
**Connochaetes**  
*gnu*, 184, 190.  
*taurinus*, 184.  
**Contopus**, 354, 358.  
**Coptobasis**  
*mesopectralis*, 77.  
**Corvinella**, 353, 358, 359, 360.  
**Cotachena**  
*aluensis*, 74.  
*trivitalis*, 74.  
**Craseomys**  
*bedfordiae*, 405, 413.  
**Cricetomys**  
*gambianus*, 295, 296.  
— *adventor*, 295.  
— *viator*, 295, 296.  
**Crocidura**  
*flavescens flavidula*, 290.  
*sylvia*, 290.  
**Crossarchus**  
*fasciatus*, 291, 292.  
— *macrurus*, 291.  
— *senescens*, 291, 292.  
*obscurus*, 198, 199, 200.  
**Crunomys**  
*fallax*, 142.  
*melanius*, 141, 142.  
**Cryptoprocta**  
*ferox*, 198.  
**Cuon**  
*alpinus*, 2.  
**Cyclorhis**, 375, 377.  
**Cylindrocæcium**, 252, 256.  
**Cymoriza**  
*ustalis*, 76.  
**Cynictis**  
*levaillanti*, 198.  
**Cynomys**  
*ludovicianus*, 212.  
**Cynopterus**  
*sphinx*, 8.  
**Dafila**  
*spinicauda*, 173.  
**Dasypus**, 192.  
*minutus*, 198.  
*villosus*, 198.  
**Dasyurus**  
*maugæi*, 206, 208.  
*viverrinus*, 206, 207.  
**Deba**  
*althealis*, 81.  
*surrectalis*, 81.  
**Dendrogale**  
*frenata*, 8.  
**Dendrolagus**  
*bennettii*, 202, 208.  
**Dichocrocis**  
*binaculalis*, 81, 87.  
*evaxalis*, 81.  
*nigrilinealis*, 81.  
*pardalis*, 81, 87.  
*punctiferalis*, 81.  
*xanthocyma*, 81.  
**Dicrurus**, 353.  
**Didelphys**, 183, 216, 220.  
*marsupialis*, 200, 216.  
*nudicaudata*, 208.  
**Dilocarcinus**, 275.  
**Dimorphodon**, 224, 225, 228, 233.  
**Diplodocus**, 231.  
**Dipus**, 219, 232.

*Dolichotis*, 208, 209, 210.  
*patagonica*, 209, 210, 216.  
*Dorcatherium aquaticum*, 190.  
*Dracænura albonigralis*, 77.  
*horochroa*, 77.  
*torridalis*, 77, 87.  
*unicoloralis*, 77.  
*Draco volans*, 229, 230.  
*Dromæus novæ-hollandiæ*, 172.  
*Dromicia nana*, 206, 208.  
*Dryoscopus*, 360.  
*Dytiscus*, 323.  
*Echidna*, 219.  
*Edolius*, 360, 367.  
*forficatus*, 365.  
*Elaphurus davidianus*, 2.  
*Elephas*, 192.  
*africanus*, 243, 247, 381, 403.  
— *albertensis*, 384, 402, 403.  
— *capensis*, 384, 385, 386, 387.  
— *cavendishi*, 394, 395.  
— *cyclotis*, 384, 389, 390, 399, 401.  
— *knochenhaueri*, 384, 388, 391, 392, 393, 394, 395, 398, 403.  
— *orleani*, 398.  
— *oryotis*, 384, 391, 394, 395, 397, 398, 399, 401, 402.  
— *peeli*, 393, 394.  
— *pumilio*, 248, 384, 400.  
— *rothschildi*, 399.  
— *selousi*, 387, 388, 389.  
— *torotis*, 385, 386, 388, 389, 390.  
— *typicus*, 384, 387.  
*antiquus*, 239, 243, 244, 245, 246, 247, 248, 249, 250.  
*capensis*, 384.  
*creticus*, 238, 239, 240, 241, 243, 244, 245, 249, 250.  
*cypricola*, 240, 241, 242, 243, 249.  
*maximus*, 239.

*Elephas*  
*melitensis*, 239, 240, 241, 242, 243, 249.  
*meridionalis*, 239, 243, 249.  
*mnaidriensis*, 246, 247, 249.  
*namadicus*, 247.  
*planifrons*, 403.  
*priscus*, 239, 243.  
*Eminoscotex*, 415, 423.  
*barnimi*, 431.  
*neumannii*, 431.  
*ruwenzorii*, 428, 430, 431.  
*sylvestris*, 431.  
*torreus*, 431.  
*viridescens*, 431.  
*Endotricha albicilla*, 74.  
*persicopa*, 74.  
*Equus*, 220.  
*chapmani*, 193.  
*Erethizon dorsatum*, 211.  
*Eriometopus*, 268.  
*Erinaceus*, 220.  
*algius*, 196, 197.  
*europæus*, 197.  
*Eristalis tcnax*, 319.  
*Eschatocephalus vespertilionis*, 328.  
*Etiella fuscalis*, 69, 87.  
*Eumeces*, 56, 58, 59.  
*algeriensis*, 59.  
*Euryceros*, 353, 357, 360, 364, 368, 371.  
*prevostii*, 369.  
*Eurypyga helias*, 2.  
*Eutephria cribrata*, 78.  
*Evotomys*, 404.  
*amurensis*, 405, 413.  
*mikado*, 405, 413.

*Felis*, 143-168.  
*sp.*, 6.  
*angorensis*, 150, 151, 167.  
*aurata*, 145.  
*aureus*, 151.  
*badia*, 145, 164.  
*bengalensis*, 6, 165.  
*cærulea*, 150.  
*caffra*, 159.  
*caligata*, 159.

*Felis*  
*catus*, 143, 149, 150, 152, 154, 155, 160, 161, 167.  
— *ferus*, 150.  
*caudata*, 162, 165.  
*chaus*, 162, 164, 165, 166.  
*domestica*, 149, 150, 167.  
*ferus*, 150.  
*hispanica*, 149, 150.  
*huttoni*, 151.  
*inconspicua*, 151, 155.  
*jaguarondi*, 145.  
*longiceps*, 151.  
*lybica*, 158, 166.  
*madagascariensis*, 151.  
*manul*, 155, 157, 161, 299, 300, 301, 302, 304, 305, 306.  
*nigripectus*, 306.  
*ocrea*, 148, 152, 155, 156, 157, 158, 159, 160, 161, 162, 163, 165, 166, 167, 290, 301, 304, 305, 306.  
— *agria*, 151.  
— *caffra*, 166, 168.  
— *sarda*, 158.  
*ornata*, 165.  
*pardalis*, 172.  
*pardus*, 198.  
*ruber*, 150.  
*rubiginosa*, 165.  
*sinensis*, 150.  
*striata*, 151, 167.  
*sylvestris*, 148, 149, 150, 152, 155, 157, 158, 159, 160, 161, 162, 163, 164, 165, 166, 167, 168, 304, 305, 306.  
*temminckii*, 145.  
*tigris*, 157.  
*torquata*, 148, 151, 152, 155, 159, 160, 161, 163, 164, 165, 167, 168.  
*vulgaris*, 149.  
*Filodes xanthalis*, 60.  
*Fredericella cunningtoni*, 250, 251, 254, 257.  
*duplessii*, 254.  
*pulcherrima*, 254.  
*regina*, 254.  
*sukina*, 251, 254.  
*walkottii*, 254.

- Funambulus**  
*bardmorei*, 10.  
*rufigenis fuscus*, 10.  
— *typicus*, 10.  
**Funisciurus**  
*cepapi*, 292.  
*frerei*, 292.  
*palliatu*, 292, 293.  
— *ornatus*, 293.  
— *swahelicus*, 294.  
*sponsus*, 292, 293.  
  
**Galago**  
*conspicillatus*, 287.  
*crassicaudata*, 197, 287.  
*granti*, 287.  
*moholi*, 286, 287.  
*moesambicus*, 287.  
*senegalensis*, 287.  
**Galeopithecus**, 227, 228, 229.  
**Galictis**  
*barbara*, 198.  
**Gallinago**  
*aequatorialis*, 29, 35.  
*aucklandica*, 28.  
*australis*, 26, 28, 34.  
*caelestis*, 12-35.  
*delicata*, 22, 24, 26.  
*frenata*, 26, 28, 34.  
*gallinula*, 22, 29, 30.  
*major*, 27, 30.  
*megala*, 31, 32, 33, 34.  
*nigripennis*, 29.  
*nobilis*, 26, 27, 34.  
*paraguayæ*, 26, 28.  
*raddii*, 21, 24.  
*solitaria*, 30, 31, 32, 34.  
*stenura*, 25, 27, 33.  
**Gardullaria**, 423.  
**Gastrosteus**  
*steindachneri*, 414.  
**Gazella**  
*euchore*, 187, 188.  
**Gecko**  
*mauritanicus*, 52.  
**Genetta**  
*sp.*, 291.  
*felina*, 199.  
*lelaba*, 291.  
**Geothelphusa**, 274.  
**Geotrupes**  
*spiniger*, 313, 318.  
*stercorarius*, 318.  
*typhaeus*, 319.  
**Gerrhonotus**, 55-59.  
*ceruleus*, 56, 57.  
*Gerrhosaurus*, 56.  
  
**Giraffa**, 100-125.  
*camelopardalis anti-quorum*, 106, 120.  
— *cottoni*, 121.  
— *wardi*, 105, 119, 122.  
*reticulatus*, 124, 125.  
**Glauconycteris**  
*papilio*, 288.  
*variegatus*, 288.  
**Glyphodes**  
*actorionalis*, 82.  
*aegealis*, 82.  
*agathalis*, 82.  
*amphitritalis*, 82.  
*bicolor*, 82.  
*brunneomarginalis*, 84, 87.  
*cæsalis*, 82.  
*canthussalis*, 82.  
*celsalis*, 82.  
*deliciosa*, 82.  
*doleschali*, 82.  
*eurygania*, 82.  
*eurytusalis*, 82.  
*exaula*, 82.  
*exquisitalis*, 84, 87.  
*flavizonalis*, 82.  
*glauculalis*, 82.  
*hilaralis*, 82.  
*hypomelas*, 82.  
*indica*, 82.  
*itisalis*, 82.  
*laccritalis*, 84, 87.  
*laticostalis*, 82.  
*margaritaria*, 82.  
*marinata*, 82.  
*multilinealis*, 83, 87.  
*ophiceralis*, 82.  
*paucilinealis*, 83, 87.  
*perspicualis*, 83, 87.  
*pfeifferæ*, 82.  
*pudicalis*, 83, 87.  
*quadristigmatis*, 83, 87.  
*sectinotalis*, 82.  
*stolalis*, 82.  
*subacusalis*, 82.  
*suralis*, 82.  
*tricoloralis*, 82.  
*umbria*, 82.  
*unionalis*, 82.  
*zelimalis*, 82.  
**Goniorhynchus**  
*gratalis*, 81.  
**Gonoptera**  
*libatrix*, 319, 322.  
**Gorilla**  
*gorilla diehli*, 237.  
**Graeculus**, 353, 357, 376.  
  
**Gulo**  
*luscus*, 198.  
**Gymnorhina**, 353, 356, 357, 359, 360, 361, 365, 367, 368, 370, 371, 372.  
*organicum*, 355, 363.  
  
**Hæmogregarina**  
*mansoni*, 284.  
*pococki*, 283.  
*rarefaciens*, 284.  
*refringens*, 284.  
*shattocki*, 284.  
**Halmaturus**  
*bennettii*, 202, 203.  
**Hapale**  
*devillei*, 99.  
*illigeri*, 99.  
*jacchus*, 98.  
**Haplochromis**  
*moftatti*, 311.  
**Hatteria**, 59.  
**Helictis**  
*personata*, 198.  
*pierrei*, 7.  
**Helix**  
*pellita*, 244.  
**Helladotherium**, 113.  
**Heloderma**, 59-68.  
*horridum*, 61.  
*suspectum*, 52, 61, 62.  
**Hemitragus**  
*jeniaicus*, 188.  
**Heortia**  
*dominalis*, 85.  
*vitessoides*, 85.  
**Herpestes**  
*bermanicus*, 6.  
*erilis*, 6.  
*griseus*, 198.  
*javanicus*, 6.  
*pulverulentus*, 198.  
*rutilus*, 6.  
**Hesperornis**, 229, 234.  
**Heterocneph**  
*scapularis*, 78.  
**Hippopotamus**  
*amphibius*, 1, 380.  
*liberiensis*, 248.  
**Hipposiderus**, 230.  
*gigas*, 230.  
**Homo**, 197.  
**Hysena**  
*crocuta*, 198, 199.  
**Hydaspitherium**, 114.  
**Hydrochaerus**  
*capybara*, 212.  
**Hydrocyon**  
*lineatus*, 307.

**Hydropotes**, 219.  
**Hydrothelphusa**, 268, 275.  
**Hyla**  
   *aerulosa*, 328.  
   *goeldii*, 139.  
   *palmaria*, 138.  
   *resinifictrix*, 135-140.  
   *taurina*, 135.  
   *tuberculosa*, 135.  
   *venulosa*, 135, 137, 139.  
**Hylobates**  
   *agilis*, 143.  
**Hymenochirus**, 327.  
**Hypsilophodon**, 231.  
**Hypsipyla**  
   *robusta*, 69.  
**Hypsiopygia**  
   *postflava*, 75.  
**Hyrax**, 219, 222.  
   *capensis*, 193, 194, 195.  
**Hystrix**, 208.  
   *cristata*, 210, 211, 216, 220.  
   *grisei*, 3.  
   *hodgsoni*, 11.  
   *subcristata*, 11.  
   *yunnanensis*, 3, 11.  
**Ichthyornis**, 234.  
**Ictonyx**  
   *capensis*, 292.  
**Iguana**, 45, 46, 56, 67.  
   *tuberculata*, 57, 58, 62.  
**Iguanodon**, 232.  
**Isocentris**  
   *minialis*, 86.  
   *miniosalis*, 86.  
**Jaculus**  
   *orientalis*, 208, 212.  
**Lacerta**, 53, 54, 55, 68.  
   *agilis*, 53.  
   *vivipara*, 414.  
**Lachesis**  
   *lanceolatus*, 50, 51.  
**Lagomys**  
   *roylei*, 212.  
**Lalage**, 353, 354.  
**Laniarius**, 354, 357, 360, 361.  
   *poliocephalus*, 355.  
**Lanius**, 353, 360.  
   *collurio*, 363.  
   *excubitor*, 358.  
**Leggada**  
   *minutoides*, 295.

**Lemur**, 220.  
   *albifrons*, 197.  
   *catia*, 197.  
   *coronatus*, 197.  
   *macaco*, 197, 209.  
   *mongoz*, 197.  
   *varius*, 197.  
   *xanthomystax*, 197.  
**Leptobrachium**, 325, 330.  
**Leptodactylus**, 337.  
   *hexadactylus*, 337.  
**Lepus**  
   *capensis*, 297.  
   — *aguiro*, 297.  
   — *centralis*, 297.  
   — *granti*, 297.  
   *europæus*, 212.  
   *ochropus*, 297, 298.  
   *timidus*, 405, 414.  
   — *aimu*, 405.  
   *vassali*, 11.  
**Lepyrodos**  
   *perspicata*, 85.  
**Leucinodes**  
   *apicalis*, 85.  
**Limnias**  
   *ceratophylli*, 251.  
**Limnomys**, 141.  
**Limnothelphusa**, 266, 267.  
   *maculata*, 267.  
**Liolummus**, 67.  
   *magellanicus*, 57.  
**Locastra**  
   *castanealis*, 72, 87.  
**Lophopodella**  
   *thomasi*, 251, 257.  
   (*Pectinatella*) *carteri*, 251.  
**Loris**  
   *gracilis*, 4.  
**Lucilia**, 323.  
**Lutra**, 220, 286.  
   *vulgaris*, 198, 199.  
**Lycaon**  
   *pictus*, 2.  
**Macalla**  
   *apicalis*, 71, 87.  
   *caradriniiformis*, 70, 87.  
   *curtullalis*, 70, 87.  
   *margarita*, 70.  
   *nyctichroalis*, 70.  
   *anochroa*, 70.  
   *perdentalis*, 71, 87.  
   *picta*, 70.  
   *pomalus*, 70, 87.  
   *porphyroalis*, 71, 87.  
   *seminivæa*, 70.  
   *tenebrosalis*, 71.  
   *unipunctalis*, 70, 87.

**Macropus**, 205, 207, 218, 220.  
   *agilis*, 201, 207.  
   *alligatoris*, 202, 207.  
   *antilopinus*, 202, 207.  
   *bennettii*, 207.  
   *bruni*, 201, 207.  
   *derbianus*, 202, 207, 216.  
   *dorsalis*, 201, 202, 207, 209.  
   *giganteus*, 202, 203, 207.  
   *melanops*, 201, 207.  
   *melanotis*, 208.  
   *rufus*, 202, 207.  
   *ualabatus*, 201, 204, 207.  
**Macroscincus**, 58, 59.  
**Macroxus**  
   *annulatus*, 293.  
   *leucopus*, 8.  
**Manis**  
   *javanica*, 11.  
**Marasmia**  
   *fusifascialis*, 79.  
**Maruca**  
   *testulalis*, 86.  
**Megalophrys**, 324, 335, 336, 339, 340, 343, 344, 345, 346, 347, 349.  
   *chysii*, 325.  
   *feæ*, 325, 330.  
   *longipes*, 326, 327, 328.  
   *montana*, 325, 326, 327, 328, 329, 349.  
   *nanula*, 325, 326, 327, 328, 329, 330, 331, 332, 340, 341, 342, 344, 346, 348, 350, 351, 352.  
**Melanomyia**, 142.  
**Mellivora**  
   *ratel*, 292.  
**Melolontha**, 322, 323.  
   *vulgaris*, 318.  
**Melurus**  
   *ursinus*, 435.  
**Merocetena**  
   *staintoni*, 85.  
**Meta**  
   *menardi*, 319.  
**Metroas**  
   *nebulalis*, 85.  
**Micralestes**  
   *acutidens*, 307.  
**Microchaetus**  
   *colletti*, 277, 278, 279.  
   *griseus*, 277, 281.  
   *microchaetus*, 278.



- Microsaurus**  
*zuluensis*, 279, 280, 281.
- Micromys**  
*agrarius*, 412.  
*geisha*, 412.  
— *celatus*, 412.  
— *geisha*, 404, 412.  
— *hokkaidi*, 405, 412.  
— *yakui*, 412.  
*speciosus*, 404, 412.  
— *ainu*, 405, 412.  
— *giliacus*, 405, 411, 412.  
— *navigator*, 412.  
— *peninsularis*, 411, 412.  
— *speciosus*, 412.
- Midas**  
*devillei*, 99.  
*elegantulus*, 91.  
*erythrogaster*, 91.  
*fuscicollis*, 88, 89, 96.  
*griseovertex*, 88, 89, 90, 91, 92, 93, 98.  
*illigeri*, 88, 93, 99.  
*imperator*, 88, 93, 94.  
*labiatus*, 88, 91.  
*mystax*, 88, 98.  
*pileatus*, 88, 97, 98.  
— *juruanus*, 98.  
*rufiventer*, 88, 89, 90, 91, 92, 93.  
*thomasi*, 89, 92.  
*weddellii*, 88, 93.
- Monodonta**, gen. nov., 69.  
*passalis*, 69, 87.
- Moschus**, 219.  
*moschiferus*, 190.
- Mungos**  
*albicaudis*, 291.  
*cafer*, 291.  
*gracilis*, 286.  
*(Ichneumia) grandis*, 291.
- Mus**  
sp., 141.  
*albigularis*, 141.  
*bagobus*, 141.  
*chrysophilus*, 295.  
*coucha*, 295.  
*norvegicus*, 404, 405, 411.  
*rattus*, 141, 295.  
*sylvaticus*, 412.  
*vulcani*, 141.
- Muscicapa**, 356, 360.
- Myiarchus**, 366.  
*arundinicola*, 354.
- Myopotamus**  
*coypu*, 181, 212, 213, 214, 215, 216, 217, 228.
- Myotis**  
*mystacinus*, 314, 404, 407.
- Myoxus**  
*lineatus*, 411.
- Myrmecophaga**  
*jubata*, 198.
- Nacoleia**  
*charesalis*, 81.
- Nandinia**  
*binotata*, 198.
- Nasua**  
*rufa*, 198.
- Nebria**  
*brevicollis*, 318.
- Nemorhædus**  
*caudatus*, 281.  
*goral*, 114.  
*swettenhami*, 188.
- Nesotragus**  
*livingstonianus*, 299.  
*zuluensis*, 299.
- Neumannia**, 415.  
*ruwenzorii*, 424, 426, 427.  
*siphonochæta*, 424, 425.  
*tenuis*, 424, 425.
- Nevrina**  
*procopia*, 80.
- Newtonia**, 360, 365, 371.  
*brunneicauda*, 369.
- Nosophora**  
*barbata*, 79.  
*dispilalis*, 79.  
*fulvalis*, 79.  
*semitritalis*, 79.
- Nycteribia**  
*hermanni*, 323.
- Nycticebus**  
*cinereus*, 5.  
*couang*, 4.  
— *cinereus*, 4.  
*pygmaeus*, 4, 5, 11.  
*tardigradus*, 4, 197.
- Nyctodactylus**, 226, 227, 228.
- Nyctosaurus**, 226, 228.
- Okapia**, 100–115, 126–135.  
*johnstoni*, 128, 129.  
*liebrechtsi*, 129.
- Omphisa**  
*ingens*, 87.
- Onychogale**  
*frenata*, 206, 208.
- Ophiosaurus**, 56, 57.  
*apus*, 57.
- Opisthocomus**, 235.
- Oreotragus**  
*saltator*, 114.
- Ornithocheirus**, 227, 229.
- Ornitholestes**, 231, 235.
- Ornithomimus**, 232.
- Orphnophanes**  
*euceralis*, 77.
- Orthaga**  
*chionalis*, 73, 87.  
*columbalis*, 74, 87.  
*fuscifuscialis*, 74, 87.  
*polychroalis*, 73, 87.  
*seminivæa*, 74.  
*vitalis*, 73.
- Oryx**  
*beatrice*, 185, 221.  
*leucoryx*, 185.
- Otocolobus**  
*manul*, 302.  
— *mongolicus*, 302.  
— *nigripictus*, 302.  
*nigripictus*, 302.
- Otocyon**, 403.
- Otomys**  
*irroratus*, 294.  
— *cupreus*, 294.
- Ourebia**  
*nigricaudata*, 185.
- Ovibos**  
*moschatus*, 114.
- Ovis**  
*cowani*, 238.  
*stonei*, 238.  
*tragelaphus*, 114, 220.
- Pachynoa**  
*spilosomoides*, 86.  
*thoosalis*, 86.
- Pachyzancla**  
*desmiodides*, 86.  
*pollidialis*, 86.
- Pagya**  
*paraphragma*, 76.
- Palæornis**  
sp., 170.
- Paludicella**, 252.  
*erecta*, 256, 257.
- Paludicola**  
*bibronii*, 328.
- Papio**  
*maimon*, 1.  
*porcarius*, 286.

Paradisea, 353, 354, 356,  
359, 371, 372.  
*raggiana*, 363.  
Paradoxurus, 4.  
*minor*, 6.  
Paramelania, 250, 255.  
Parascoler, 426.  
Parathelphusa, 275.  
Parthenodes  
*rectangularis*, 77, 87.  
Pedetes  
*cafer*, 282, 296.  
Pelobates, 326, 327, 333.  
335, 337, 340, 341,  
342, 344, 350, 351,  
352.  
*cultripes*, 331.  
*fuscus*, 326, 329, 334,  
347, 349.  
Pelodytes, 338, 340, 341,  
342.  
*punctatus*, 339, 341.  
Perameles  
*obscula*, 206, 208.  
Perodicticus  
*potto*, 197.  
Petaurista  
*lylei*, 3, 8.  
*yunnanensis*, 3, 8.  
Petaurus, 228.  
*breviceps*, 206, 208.  
Petrodromus, 285.  
*schwanni*, 289, 290.  
*sultan*, 289, 290.  
Petrogale  
*penicillata*, 205, 207.  
*xanthopus*, 205.  
Phacochoerus  
*ethiopicus*, 188, 189.  
Phascologale  
*penicillata*, 206, 208.  
Phascodomys  
*mitchelli*, 204, 205,  
207.  
Phelsuma, 58.  
Pheretima, 424.  
Philohela  
*minor*, 34.  
Phryganodes  
*basalticoides*, 80.  
*glyphodalis*, 80.  
*maculicostalis*, 80.  
*margarita*, 81.  
*obscurata*, 80.  
*odontoticta*, 80.  
Phrynosoma, 46.  
Phycita  
*dinawa*, 69, 87.  
Physignathus, 52.  
Phytotoma, 353, 354,  
356, 357.

Piezorhynchus, 360.  
Pileocera  
*inconspicualis*, 78, 87.  
Pilocrocis  
*anigrusalis*, 79.  
*coptobasis*, 79.  
Pionea  
*ablactalis*, 86.  
*albifimbrialis*, 86.  
*bractealis*, 86, 87.  
*nypsiusalis*, 86.  
Pipa, 327, 332, 333, 342,  
343, 344, 345, 352.  
Pipistrellus  
*nannus*, 288.  
*pipistrellus*, 318.  
Pitangus, 353, 357, 365.  
Pitta, 353, 367.  
*baudi*, 362.  
Pityriasis, 353, 360, 361,  
365, 367, 368, 371.  
Platythelphusa, 266, 267,  
268, 274, 275.  
*armata*, 259, 266, 267,  
268, 269, 271, 272,  
274, 276.  
*conculcata*, 259, 268,  
273, 276.  
*maculata*, 259, 268,  
270, 271, 273, 274,  
275, 276.  
Plecotus  
*auritus*, 405, 406.  
Pleuronectes  
*flesus*, 175, 180.  
*macrocephalus*, 180.  
*platessa*, 180.  
Plumatella  
*repens*, 250, 251, 253.  
*tanganyika*, 250, 251,  
252, 257.  
Polychrus, 40.  
*marmoratus*, 47.  
Polygrammodes  
*grossalis*, 87.  
*purpuralis*, 87.  
Polylophota  
*barbarossa*, 72.  
*truncalis*, 72, 87.  
Polythlipta  
*divaricata*, 85.  
*macralis*, 85.  
Polytoreutus, 429.  
*bettonianus*, 416.  
*caeruleus*, 422.  
*granti*, 420, 421, 422,  
423.  
*gregorianus*, 420.  
*kirimanis*, 415, 417,  
418, 419, 420, 422,  
423.

Polytoreutus  
*magidensis*, 422.  
*ruwenzorii*, 415, 416,  
417, 418, 419, 420,  
421, 422, 423.  
*sylvestris*, 415, 416,  
417, 418, 419, 422,  
423.  
*usindjaensis*, 415, 418,  
419.  
Porcula  
*salvania*, 190.  
Potamocarcinus, 275.  
Potamocherus  
*africanus*, 190.  
*chaeropotamus nyasa*,  
298.  
Potamon, 267, 268, 274,  
275.  
*ambiguus*, 265.  
*hilyendorfi*, 261, 263.  
*johnstoni*, 260, 261,  
263.  
*mrogoroensis*, 265, 266.  
*perlatus*, 263, 264.  
*suprasulcatus*, 265.  
(*Geothelphusa*) *emini*,  
274.  
(*Parathelphusa*) *nilo-*  
*ticus*, 274, 276.  
(*Potomonautes*), sp.,  
259, 262, 266.  
(—) *celebensis*, 262,  
263.  
(—) *inflatus*, 259.  
(—) *orbitospinus*, 259,  
260, 261, 274, 276.  
(—) *perlatus*, 263, 264,  
276.  
(—) *platynotus*, 259,  
264, 265, 266, 270,  
276.  
Potamonautes, 268, 274.  
Pottsiella, 252, 256.  
Presbytes  
sp., 4.  
*nigripes*, 4.  
Prionops, 353, 354, 357,  
359.  
Proædema  
*incisalis*, 86.  
Procyon  
*cancrivorus*, 196.  
*lotor*, 198, 199.  
Proteles  
*cristata*, 198.  
Protoceros, 114.  
Pseudaspis  
*oana*, 284.  
Pseudochirus  
sp., 206, 208.

- Pseudochirus**  
*peregrinus*, 206, 220.  
**Pterodactylus**, 225, 226, 228.  
**Pteromys**, 227, 228, 229.  
*russicus*, 409.  
*yunnanensis*, 8.  
**Pteropus**, 226, 229.  
*vulgaris*, 229.  
**Pterostichus**  
*niger*, 319.  
**Psiloceris**  
*lowi*, 233.  
**Pycnarmon**  
*jaguaralis*, 78.  
*lactiferalis*, 78.  
**Pygospila**  
*bivittalis*, 85.  
*imperialis*, 85, 87.  
*marginalis*, 85, 87.  
**Pyrausta**  
*cederalis*, 87.  
*celatalis*, 87.  
*eripialis*, 87.  
*tritralis*, 87.  
**Python**  
*molurus*, 283.  
*spilotes*, 284.  
**Rana**  
*amurensis*, 414.  
*esculenta*, 328, 331, 332, 339, 343, 348.  
— *chinensis*, 414.  
*guppyi*, 331, 333, 334, 337, 338, 339, 342, 343, 344, 345, 346, 348, 349, 350, 351, 352.  
*temporaria*, 414.  
*tigrina*, 331, 334, 337, 345, 348.  
**Rhinena**  
*phrynealis*, 78.  
**Rhacophorus**  
*sp.*, 348, 352.  
**Rhamphocelus**  
*brasilus*, 143.  
**Rhamphorhynchus**, 225, 228, 229, 233.  
**Rhaphicerus**, 185, 191.  
*horstocki*, 237.  
— *natalensis*, 237.  
*melanotis*, 184.  
*neumanni capricornis*, 298.  
**Rhimphalea**  
*keranialis*, 79.  
*linealis*, 79, 87.  
**Rhimphalea**  
*scelatalis*, 79.  
*trogusalis*, 80.  
**Rhinolophus**  
*cornutus*, 405, 406.  
*ferrum-equinum*, 312, 323, 324.  
— *nippon*, 405, 406.  
*hipposiderus*, 312, 314, 323.  
**Rhizomys**  
*pruinusos*, 10.  
**Rhombus**  
*maximus*, 178.  
**Rhynchocycelus**, 354, 358.  
**Sacada**  
*inordinata*, 75.  
*nigropunctata*, 75.  
**Saccostomus**  
*campestris*, 204, 205.  
*fuscus*, 204, 205.  
**Sameodes**  
*tristalis*, 85, 87.  
**Samotherium**, 113.  
**Sayornis**, 358, 364, 366.  
*cineracea*, 355, 362.  
**Scaphiopus**, 327, 341.  
*solitarius*, 328.  
**Scaphognathus**, 229.  
**Sciuropterus**  
*buechneri*, 410.  
*momonga*, 409.  
— *amygdali*, 409.  
*russicus*, 404, 409, 410.  
— *athene*, 404, 409.  
**Sciurus**, 220.  
*americanus volans*, 409.  
*berdmorci*, 10.  
*bicolor*, 212.  
*griseimanus*, 8, 9.  
*leucopus*, 8, 9.  
— *fumigatus*, 9.  
— *typicus*, 9.  
*maccllellandi*, 4.  
— *barbei*, 4.  
— *maritimus*, 4, 9.  
— *rodolphi*, 4, 10.  
*maximus*, 212.  
*mindanensis*, 141.  
*mouhoti*, 10.  
*orientis*, 410.  
*palmarum*, 212.  
*rodolphi*, 10.  
*vassali*, 9.  
*vulgaris*, 212.  
— *orientis*, 405, 410, 411.  
— *rupestris*, 404, 410.  
**Scelopax**  
*rusticola*, 34.  
**Scotophilus**  
*damarensis*, 287.  
*kuklii*, 8.  
*minimus*, 288.  
*nigrita*, 287, 288.  
— *herero*, 287.  
*planirostris*, 287.  
*schlieffeni*, 288.  
*viridis*, 287.  
**Scotozia**  
*dubitata*, 319, 322.  
**Semnopithecus**  
*nigripes*, 4.  
**Seps**, 58.  
**Siciata**  
*caudata*, 404, 405, 413, 414.  
*concolor*, 413, 414.  
*leathemi*, 413, 414.  
*subtilis*, 414.  
*tianshanica*, 414.  
**Sivattherium**, 113.  
**Sorex**  
*araneus*, 407.  
*huxtoni*, 408.  
*daphenodon*, 404, 407.  
*gracillimus*, 404.  
*minutus*, 404, 409.  
— *gracillimus*, 408.  
*pygmaeus*, 409.  
*shintu*, 408.  
— *vacus*, 404, 405, 408.  
*unguiculatus*, 404, 405, 407.  
**Sparganum**  
*haxleri*, 282.  
*hematophium*, 283.  
*japonicum*, 283.  
*mansonii*, 283.  
**Sphecotheres**, 358, 376.  
**Spinturnix**  
*vespertilionis*, 324.  
**Spongilla**  
*tanganyika*, 250, 256.  
**Steriota**  
*cornucalis*, 73, 87.  
*divitalis*, 72.  
*flammealis*, 72, 87.  
*harraldusalis*, 72.  
*prasina*, 72.  
*sporeta*, 72.  
*subviridialis*, 73, 87.  
**Streptospondylus**, 231.  
**Suricata**, 220.  
*tetradactyla*, 199.  
**Sus**  
*sp.*, 142.  
*acrofa*, 190.

- Sylepta*  
*acridentalis*, 82.  
*aurantiacalis*, 81.  
*chalybifuscia*, 81.  
*chromalis*, 81.  
*dissipitalis*, 81.  
*multilinealis*, 81.  
*ochrifusalis*, 82.  
*pernitescens*, 81.  
*solitudo*, 81.
- Syngamia*  
*amphistalis*, 79.  
*floridalis*, 79.  
*marmorata*, 79.
- Tachyphonus*  
*coronatus*, 143.
- Tænipterus*, 358.
- Talanga*  
*tolumialis*, 77.
- Tamandua*  
*tetradactyla*, 198.
- Tanias*  
*asiaticus*, 404, 411.  
*lineatus*, 405, 411.
- Taphozous*, 225.
- Tarentola*, 58.
- Tatera*  
*beckuanae*, 294.  
*lobengule beckuanae*, 294.
- Taurotragus*  
*oryx*, 380.
- Telodrilus*, 423.
- Terminoptycha*  
*cyanopa*, 74.
- Terpsiphone*, 356, 359, 360, 362, 366.
- Tetraceros*, 114, 115.
- Thamnomys*  
*arborarius*, 295.  
*dolichurus*, 295.
- Thliptoceras*  
*octoguttale*, 85.
- Thrasaetus*  
*harpyia*, 281.
- Thryononyx*  
*runderianus*, 286.
- Thylacinus*  
*cynocephalus*, 207.
- Tilapia*  
*natalensis*, 311.  
*sparrmani*, 311.
- Tiliqua*, 53, 54, 55, 57.  
*scincoides*, 49, 54, 58, 59.
- Tipuliforma*, gen. nov., 75.  
*triangulalis*, 75, 87.
- Totanus*  
*glareola*, 30.
- Trachydosaurus*, 53, 55, 58.  
*rugosus*, 58.
- Tragulus*, 193, 195.  
*affinis*, 11.  
*kanchil affinis*, 11.  
*— pierreii*, 11.  
*meminna*, 191, 192.  
*ravus*, 11.
- Tribelesodon*, 227, 228.
- Trichælurus*, 302.
- Trichosurus*  
*vulpes*, 203, 208.
- Triphæna*, 319.  
*orbana*, 322.  
*pronuba*, 322.
- Tropidonotus*  
*vibakari*, 414.
- Tupaia*  
*belangeri*, 7.  
*chinensis*, 3, 7.  
*concolor*, 7.  
*everetti*, 140.  
*ferruginea*, 4.  
*frenata*, 8.
- Tupinambis*, 58.
- Tylas*, 353, 361, 370, 371, 376.
- Tyrannus*, 353, 361, 366, 370.
- Tyspanodes*  
*radiata*, 80, 87.
- Ulopeza*  
*cruciferalis*, 79, 87.
- Urogale*  
*cyliindrura*, 140.  
*everetti*, 140.
- Uromastix*  
*acanthinurus*, 58.
- Ursus*  
*americanus*, 433.  
*arctos*, 433, 434.  
*ferox*, 434.  
*horribilis*, 433.  
*maritimus*, 435.  
*torquatus*, 435.
- Valdivia*, 275.
- Varanus*, 48, 55, 59-68.  
*bengalensis*, 65.  
*exanthematicus*, 63, 64, 65, 67.
- Varanus*  
*gouldii*, 63.  
*griseus*, 63, 65, 66.  
*niloticus*, 55, 63, 64, 65, 67.  
*ocellatus*, 65, 67.  
*salvator*, 63.
- Varicorhinus*  
*ansorgii*, 311.  
*brucii*, 310, 311.
- Vespa*, 323.
- Vespertilio*, 228.  
*sphinx*, 8.
- Victorella*, 251, 253, 256.  
*pavida*, 252, 256, 257.  
*symbiotica*, 251, 253, 257.
- Vipera*  
*berus*, 414.  
*rusnelli*, 51.
- Vireo*  
*olivacea*, 362.
- Vireolanius*, 353, 354, 359, 371, 375, 377.  
*leucotis*, 362.
- Vitessa*  
*griseata*, 75.  
*sauradeva*, 75, 87.  
*zemira*, 75.
- Viverra*  
*civetta*, 198, 290.  
*malaccensis*, 6.  
*megaspila*, 6.
- Viverricula*  
*malaccensis*, 6.
- Wollecomia*  
*smithelli*, 282.
- Xenophrys*, 330.  
*monticola*, 340, 342, 352.
- Xenopirostris*  
*pollens*, 376.
- Xenopus*, 327, 344, 345, 346.
- Xylophasia*  
*polyodon*, 322.
- Zamenia*  
*flagelliformis*, 284.
- Zinckenia*  
*fascialis*, 78.
- Zonurus*, 52-55, 67, 68.  
*cordylus*, 53.  
*giganteus*, 48, 49, 52, 55.

**P. Z. S. 1907, pp. 1 236,  
were published on June 12th, 1907.**

ABSTRACT OF THE PROCEEDINGS  
OF THE  
ZOOLOGICAL SOCIETY OF LONDON.\*

January 15th, 1907.

Dr. J. ROSE BRADFORD, F.R.S., Vice-President, in the Chair.

The SECRETARY read a report on the additions that had been made to the Society's Menagerie during the months of November and December 1906.

Mr. OLDFIELD THOMAS, F.R.S., exhibited the skin of a new Monkey from the Ituri Forest, obtained during the recent Ruwenzori Expedition, and diagnosed it as follows :—

*CERCOPITHECUS DENTI*, sp. n.

Allied to *C. campbelli*, but not darkened on the posterior back and hind limbs, the outer side of these latter being grizzled olive-yellowish to the ankles. Under surface and inner side of limbs very sharply defined creamy white. Tail greyish white, darkening terminally to black.

*Hab.* Ituri Forest.

*Type.* Male. Original number 184. Collected by R. E. Dent.

Mr. P. H. BAHR, F.Z.S., read a paper "On the 'Bleating' or 'Drumming' of the Snipe (*Gallinago caelestis*).” The object of the paper was to prove that this phenomenon was produced by the tail-feathers of this species, a point which had been much disputed. It was found that if the feathers were attached to a cork in a special manner, the peculiar bleating sound could be produced, and, furthermore, that only two feathers in this species were the active agents in producing the sound. Observation

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proved that these two feathers were held in a particular manner in front of the others during the bird's flight in the breeding-season. Feathers of both male and female were found to bleat, a fact which had been borne out by numerous observers in the field. These feathers were found to have a peculiar structure, differing materially from the other feathers in the tail. Microscopically they differed, and the number of hamuli were found to be in excess of those found in other feathers. The feathers of various exotic species had been experimented upon, and those of *G. delicata*, *nobilis*, *frenata*, *paraguayæ* in the New World, *G. australis* and *aucklandica* in the Antipodes, and *G. solitaria* and *megala* in Asia had been found to produce musical sounds. These feathers varied in structure, and consequently the sound produced differed accordingly. The feathers of *G. gallinula*, *G. major*, and *G. stenura* were not found to be musical.

Mr. J. L. BONHOTE, F.Z.S., communicated a paper on a collection of Mammals from Annam sent home by Dr. Vassal. Twenty-four species were enumerated, of which the following four were described as new:—

1. *NYCTICEBUS PYGMÆUS*, sp. n.

Similar in general colouring to, but about half the size of, *N. coucang*, and without any dark markings round the eyes or down the back. The teeth are quite different, the second molar being the largest, whilst the third molar is triangular in shape and but little inferior in size to the first.

2. *TUPAIA CONCOLOR*, sp. n.

Similar in general colouring to *T. belangeri*, but larger, with a much thicker tail and lacking the light neck-stripe.

3. *SCIURUS LEUCOPUS FUMIGATUS*, subsp. n.

Similar to *S. leucopus*, but darker, and the outer sides of the limbs concolorous with the back.

4. *FUNAMBULUS RUFIGENIS FUSCUS*, subsp. n.

Similar to *F. r. typicus*, but much darker in general coloration and having a rufous tinge on the outer sides of the thighs.

A paper was read from Dr. EMIL A. GOELDI, C.M.Z.S., containing descriptions of seven new or little-known species of Marmoset Monkeys from the Amazonian Region.

Mr. F. E. BEDDARD, F.R.S., read a paper entitled "Contributions to the Knowledge of the Systematic Arrangement and Anatomy of certain Genera and Species of Squamata."

A communication was read from Mr. GEORGE H. KENRICK, F.Z.S., containing a list, with descriptions of the new species, of *Pyralidæ* collected by Mr. A. E. Pratt in British New Guinea in 1902-03.

The next Meeting of the Society for Scientific Business will be held on Tuesday, the 5th February, 1907, at half-past Eight o'clock P.M., when the following communications will be made:—

1. Prof. E. RAY LANKESTER, F.R.S.—On the Fœtus of the Giraffe.

2. Dr. W. T. CALMAN, F.Z.S.—On new or rare Cumacea from the Collection of the Copenhagen Museum. Part I.

3. Dr. E. A. GOELDI, C.M.Z.S.—Description of a new Amazonian Tree-Frog with peculiar Breeding-habits.

The following Paper has been received:—

Mr. C. J. WITH.—An Account of the South-American *Cheliferinae* in the Collections of the British and Copenhagen Museums.

Communications intended for the Scientific Meetings of the ZOOLOGICAL SOCIETY OF LONDON should be addressed to

P. CHALMERS MITCHELL, *Secretary*.

3 HANOVER SQUARE, LONDON, W.

January 22, 1907.





ABSTRACT OF THE PROCEEDINGS  
OF THE  
ZOOLOGICAL SOCIETY OF LONDON.\*

February 5th, 1907.

H.G. THE DUKE OF BEDFORD, K.G., President, in the Chair.

Mr. F. MARTIN DUNCAN, by permission of the Charles Urban Trading Co., Ltd., gave a cinematograph exhibition of animals in the Society's Gardens and other Zoological Studies, chiefly on the life-history of Insects.

Mr. OLDFIELD THOMAS, F.R.S., exhibited a collection of Mammals and Birds from the Islands of Saghalien and Hokkaido, N. Japan, made by Mr. Malcolm P. Anderson in carrying out the Duke of Bedford's Exploration of Eastern Asia. Mr. Thomas proposed to give a full account of the Mammals on a later occasion.

Mr. OLDFIELD THOMAS also read a paper on Mammals collected in Mindanao, Philippines, by Mr. M. P. Anderson for the Duke of Bedford's Exploration of Eastern Asia. Seven species were mentioned, of which the following was new:—

*CRUNOMYS MELANIUS*, sp. n.

Rather larger than *C. fallax*, of Luzon. Colour wholly dark blackish brown, not lighter below; limbs and tail also uniformly dark.

Dimensions of type:— Head and body 98 mm.; tail 68; hind foot 25. Upper molar series 4.1.

*Hab.* Mt. Apo, Mindanao. *Type.* Male. No. 751.

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Prof. E. RAY LANKESTER, F.R.S., Director of the British Museum (Natural History), read a paper entitled "The Origin of the Lateral Horns of the Giraffe in Fœtal Life on the Area of the Parietal Bones." The author described and showed the exact relation of the lateral horns in the fœtus taken from the Giraffe which died last spring in the Society's Gardens. It was demonstrated that the lateral horn of the Giraffe was exclusively in origin a part of the fibrous osteogenetic tissue of the parietal bone of which it was a part, and had no connection whatever with the frontal.

Thus the statement made by Sir Richard Owen in his account of a new-born Giraffe, in a paper read before the Society in 1839, was finally shown to be based on an unfortunate accident. Owen had cut out the horn-bearing area of the skull and after an interval of time had reversed the relations of the excised piece of bone, taking frontal for parietal and parietal for frontal.

The author expressed the opinion that the *parietal* lateral horn of the Giraffe could not be considered to be the same morphological unit as the frontal lateral horn of the Okapi.

Prof. LANKESTER also read a paper on "Parallel Hair-fringes and Colour-striping on the Face of Fœtal and Adult Giraffes," in which he described, illustrated by lantern-slides, a remarkable colour-banding or striping of the hairy covering of the face in the fœtal Giraffe, and showed that similar dark and light striping occurred in a very marked form in adult Giraffes though not in all individuals.

In a third paper, "On the Existence of Rudimentary Antlers in the Okapi," Prof. LANKESTER described the polished tip or apex of the Okapi's horn which breaks through the integument. He showed that transverse fissures or incisions were produced one behind the other in the naked apex, tending to cut off in succession a series of small bony caps which he regarded as rudimentary antlers. He expressly refrained from concluding that this formation of minute antler-caps was to be regarded as genetically connected with the antler-formation of the Cervidæ, though such a connection was possible.

Prof. LANKESTER also exhibited the skull of a sub-adult male Okapi obtained by Major Powell-Cotton in the Ituri Forest (Congo), and a similar somewhat younger male skull, obtained by Capt. Boyd Alexander in the Bahr-el-Ghazal region. Both skulls were in a very fine state of preservation.

Mr. G. A. BOULENGER, F.R.S., on behalf of Dr. E. A. GOELDI, C.M.Z.S., exhibited and described a new Amazonian Tree-Frog, *Hyla resinifictrix*, closely related to *H. venulosa*, but distinguished by fully half-webbed fingers. This frog was remarkable for its habit of making good-sized basins of resinous substances in hollow branches of high trees, in which water collects, which served as a

nursery for the eggs and larvæ. The frog collected the resin from the bark of certain trees, such as the aromatic "brew-branco" (*Protium heptaphyllum*).

Dr. W. T. CALMAN, F.Z.S., read the first part of a paper on the Collection of Cumacea in the Copenhagen Museum. Altogether 30 species were dealt with, of which 25 were described as new. The majority of the specimens were derived from collections made in New Zealand and the Gulf of Siam by Mr. H. Suter and Dr. Th. Mortensen respectively.

The next Meeting of the Society for Scientific Business will be held on Tuesday, the 19th February, 1907, at half-past Eight o'clock P.M., when the following communications will be made:—

1. Mr. R. I. Pocock, F.Z.S.—On English Domestic Cats.
2. Dr. C. G. SELIGMANN, F.Z.S.—On Deaths occurring in the Society's Gardens during 1906.
3. Mr. J. T. CUNNINGHAM, F.Z.S.—On a peculiarly Abnormal Specimen of the Turbot.
4. Baron F. NOPCSA.—Ideas on the Origin of Flight.

The following Papers have been received:—

1. Mr. C. J. WITH.—An Account of the South American *Cheliferine* in the Collections of the British and Copenhagen Museums
2. Dr. R. BROOM, C.M.Z.S.—On the Dental Succession in the Cape Golden Moles.
3. Mr. F. E. BEDDARD, F.R.S.—On the Azygos Veins in the Mammalia.
4. Mr. F. E. BEDDARD, F.R.S.—On Two new Species of the African Genus *Microchaetus* belonging to the Collection of Oligochaeta in the Museum of Christiania.
5. Miss DOROTHEA M. A. BATE.—On Elephant Remains from Crete, with Description of *Elephas creticus*, sp. nov.
6. Mr. CHARLES F. ROUSSELET.—Zoological Results of the Third Tanganyika Expedition, conducted by Dr. W. A. Cunningham, 1904-05. Report on the Polyzoa.

Communications intended for the Scientific Meetings of the ZOOLOGICAL SOCIETY OF LONDON should be addressed to

P. CHALMERS MITCHELL, *Secretary*.

3 HANOVER SQUARE, LONDON, W.

February 12, 1907.



ABSTRACT OF THE PROCEEDINGS  
OF THE  
ZOOLOGICAL SOCIETY OF LONDON.\*

February 19th, 1907.

Sir EDMUND G. LODER, Bt., Vice-President, in the Chair.

The SECRETARY read a report on the additions that had been made to the Society's Menagerie during the month of January 1907.

Dr. C. I. FORSYTH MAJOR, F.Z.S., exhibited remains of a Bear from the superficial deposits of a cavern in the mountains of Corsica, where Bears, though now extinct, were formerly numerous, at least up to the sixteenth century. Despite the fact that no truly fossil Bears were as yet known from Corsica, Dr. Forsyth Major considered the Corsican Bear to have been autochthonous, whilst in his opinion the recent Mammals of Corsica (and Sardinia) had been, almost without exception, introduced by human agency. In any case they could not be adduced as proofs of a recent connection of those islands with either of the neighbouring continents.

In a paper on English Domestic Cats, Mr. R. I. Pocock urged that the surest basis for their classification and the most satisfactory clue to their descent was furnished by the two distinct patterns found in so-called Tabby Cats. In one type the pattern consisted of narrow vertical stripes; in the other of longitudinal or obliquely longitudinal stripes which, on the sides of the body, tended to assume a spiral or subcircular arrangement characteristic of the "blotched" Tabby. This distinction was long ago pointed out by Blyth.

One or the other of these types was to be found in Cats of almost all breeds, whether "Persian," "Short-haired," or "Manx." There appeared to be no intermediate stages between the two. The Cats of the "striped" type were no doubt descended from the European Wild Cat and the North-African Wild Cat; but the origin of

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Cats exhibiting the "blotched" pattern appeared to be unknown. It was to the Cat of the latter kind that Linneus gave the name *catus*, which was therefore no longer available for the European Wild Cat; this Cat, therefore, must take the name *sylvestris*.

Dr. C. G. SELIGMANN, the Society's Pathologist, in presenting his report on the deaths that had occurred among the Mammals and Birds in the Menagerie during 1906 stated that 356 Mammals and 283 Birds were submitted to post-mortem examination, and the results showed—

- (i) That tuberculosis occurring in birds in the Gardens was usually due to infection by the gut.
- (ii) The hearts of Rheas, Cassowaries, Ostriches, and some of the larger Storks kept in the Gardens were often extremely flabby, and death in these birds was in a large number of cases due to cardiac failure.
- (iii) New growths were rare both in mammals and in birds, but one case of carcinoma arising in the kidney and occurring in a Chilian Pintail (*Dafila spinicauda*) had been observed, as well as two instances of benign new growths occurring in birds not inmates of the Gardens.

Mr. J. T. CUNNINGHAM, M.A., F.Z.S., described a peculiarly abnormal specimen of the Turbot. The specimen was captured by Miss Olivia Fox, of Falmouth, near Padstow, on the north coast of Cornwall. It was a young fish, measuring only 4.4 cm. in length, and a normal specimen of slightly smaller size, taken at the same time, was completely metamorphosed to the asymmetrical condition of the adult. In the abnormal specimen the right side was almost entirely destitute of colour as in the normal condition, but both eyes were on this white side, instead of being on the left side as in normal Turbot. On the left side pigment was present over the whole surface except the head and the anterior part of the base of the dorsal fin, which were white. The fish was kept alive in captivity for two months, and was observed to lie always with its eyes uppermost, so that the upper side was white and the lower side coloured. The fish showed also another abnormality, namely, that the base of the dorsal fin projected anteriorly as a free process above the dorsal eye, a peculiarity which is usually present in ambicolorate Turbot. As there was some pigment on the head on the left side, Mr. Cunningham pointed out that the specimen might be regarded as a Turbot in which a normal body was united with a head which was reversed, so that the left side of the head, bearing the eyes and pigment, was joined to the right side of the body bearing no pigment, and *vice versa*.

Dr. BARON FRANCIS NOPOSA read a communication entitled "Ideas on the Origin of Flight," and illustrated his argument with lantern-slides showing the hind limbs of various genera of Bats, Pterosaurs, Birds, and Dinosaurs, as well as a reconstruction of a hypothetical, cursorial primitive bird. The author

stated that from the mechanical point of view a patagium and a set of flight-feathers were different organs. He pointed out the osteological analogies between Bats and Pterosaurs on the one hand, and between Birds and Dinosaurs on the other. He suggested that Bats and Pterosaurs had arisen from leaping, arboreal forms, whilst Birds had come from a terrestrial, cursorial stock.

Mr. F. E. BEDDARD, F.R.S., read a paper on the Azygos Veins in the Mammalia.

The next Meeting of the Society for Scientific Business will be held on Tuesday, the 5th March, 1907, at half-past Eight o'clock P.M., when the following communications will be made :—

1. The Hon. WALTER ROTHSCHILD, M.P., F.Z.S.—Descriptions of some new Species and Subspecies of Antelopes and of a new Sheep.

2. Miss DOROTHEA M. A. BATE.—On Elephant Remains from Crete, with Description of a new Species.

3. Mr. CHARLES F. ROUSSELET.—Zoological Results of the Third Tanganyika Expedition, conducted by Dr. W. A. Cunningham, 1904–05. Report on the Polyzoa.

4. Dr. W. A. CUNNINGTON.—Zoological Results of the Third Tanganyika Expedition, conducted by Dr. W. A. Cunningham, 1894–05. Report on the Brachyurous Crustacea.

The following Papers have been received :—

1. Mr. C. J. WITH.—An Account of the South American *Cheliferina* in the Collections of the British and Copenhagen Museums.

2. Dr. R. BROOM, C.M.Z.S.—On the Dental Succession in the Cape Golden Moles.

3. Mr. F. E. BEDDARD, F.R.S.—On Two new Species of the African Genus *Microchaetus* belonging to the Collection of Oligochaeta in the Museum of Christiania.

4. Mr. T. A. COWARD, F.Z.S.—On the Winter Habits of the Greater Horseshoe and other Cave-haunting Bats.

Communications intended for the Scientific Meetings of the ZOOLOGICAL SOCIETY OF LONDON should be addressed to

P. CHALMERS MITCHELL, *Secretary*.

3 HANOVER SQUARE, LONDON, W.

February 26, 1907.





ABSTRACT OF THE PROCEEDINGS  
OF THE  
ZOOLOGICAL SOCIETY OF LONDON.\*

March 5th, 1907.

FREDERICK GILLETT, Esq., Vice-President, in the Chair.

The Hon. WALTER ROTHSCHILD, M.P., F.Z.S., exhibited a mounted specimen of a Gorilla, *Gorilla gorilla diehli*.

Mr. ROTHSCHILD also described the Natal form of the Steinbuck as being darker and more vinaceous rufous in colour, and the North Rhodesian Reedbuck as having greyer body and less rufous head and stouter horns than the typical forms; a new Lechwe allied to both *Cobus lechwe* and *C. smithemanni*, but with black patches only on the shoulders and black hairs scattered about the neck; and a new Sheep allied to *Ovis stonoi*, but almost entirely black.

A communication from Miss DOROTHEA M. A. BATE contained an account of the discovery, in cave-deposits in Crete, of remains of Elephants, some of which were referred to a new species.

Mr. CHARLES F. ROUSSELET read a report on the Polyzoa of the Third Tanganyika Expedition. Five species were represented in the collection, three of which were described as new. Of the five species, three belonged to the Phylactolæmata and two to the Gymnolæmata. Amongst the latter was *Arachnoidia ray-lankesteri* Moore, which was found in some abundance on shells dredged from deep water.

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Dr. W. A. CUNNINGTON, F.Z.S., read a report on the Brachyurous Crustacea of the Third Tanganyika Expedition. The collection contained specimens from both Nyasa and Tanganyika. Including a few individuals which had hitherto passed without notice in the collection of the British Museum, there were now on record three species from Nyasa and five from Tanganyika. Of these species, three were described as new. The forms from Nyasa all belonged to the widely distributed subgenus *Potamonarutes*; but while two species from Tanganyika also belonged to that subgenus, the lake contained three species belonging to the remarkable endemic genus *Platythelphusa* A. Milne-Edwards. The suggested marine appearance of *P. armata* was considered to be only superficial, and the peculiar character of the Brachyuran fauna of Tanganyika could be explained on the grounds of a prolonged isolation of the lake.

Mr. F. E. BEDDARD, F.R.S., described two new species of African Oligochæte Worms of the genus *Microchætus* belonging to the collection of the Christiania Museum.

The next Meeting of the Society for Scientific Business will be held on Tuesday, the 19th March, 1907, at half-past Eight o'clock P.M., when the following communications will be made:—

1. Dr. L. W. SAMBON, F.Z.S.—On some new or little-known Animal Parasites.
2. Mr. HERBERT F. STANDING, M.Sc.—On recently Discovered Sub-fossil Prosimiæ from Madagascar, their Affinities with extant Lemurs and with the higher Primates.
3. Messrs. OLDFIELD THOMAS, F.R.S., F.Z.S., and R. C. WROUGHTON, F.Z.S.—The Rudd Exploration of South Africa.—VII. List of Mammals obtained by Mr. Grant at Coguno, Inhambane.

The following Papers have been received:—

1. Mr. C. J. WITH.—An Account of the South American *Cheliferinae* in the Collections of the British and Copenhagen Museums.
2. Mr. T. A. COWARD, F.Z.S.—On the Winter Habits of the Greater Horseshoe and other Cave-haunting Bats.

Communications intended for the Scientific Meetings of the ZOOLOGICAL SOCIETY OF LONDON should be addressed to

P. CHALMERS MITCHELL, *Secretary*.

3 HANOVER SQUARE, LONDON, W.

March 12th, 1907.

ABSTRACT OF THE PROCEEDINGS  
OF THE  
ZOOLOGICAL SOCIETY OF LONDON.\*

March 19th, 1907.

Dr. HENRY WOODWARD, F.R.S., Vice-President, in the Chair.

The SECRETARY read a Report on the additions that had been made to the Society's Menagerie during the month of February 1907.

Mr. HERBERT F. STANDING read a paper, illustrated by lantern-slides and large series of photographs and specimens, on recently discovered subfossil Prosimiæ from Madagascar, in which he discussed their affinities with extant Lemurs and with the higher Primates. The remains were obtained in the muddy bed of a swamp formed by the blocking-up of the river Mazy by a lava-flow, at from a few inches to 3 or 4 feet below the surface. They consisted of a large number of skulls and limb-bones of Lemurs and Lemur-like animals. This great amount of material enabled the author to corroborate the view, previously put forward by Dr. Forsyth Major, that the extinct Lemurs of Madagascar were, in many respects, intermediate between existing Lemurs and Monkeys, and to express his belief that the New World Monkeys and the Lemuridæ, as well as the Malagasy Indrisinæ, had a common origin. He also stated his opinion that, in view of the recent additions to our knowledge of the Prosimiæ and of what the present collection revealed with regard to their close relationship to the Apes, it was not possible to separate the Primates, as hitherto, into the two suborders Lemuroidea and Anthroproidea.

Dr. L. W. SAMBON, F.Z.S., read a paper on animal parasites, and described three new species as follows:—

*WELLCOMIA MITCHELLI*, gen. et sp. nov.

*Habitat.* Small intestine of *Pedetes caffer*.

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Only females found, 12–15 mm. long and about 1 mm. broad. Characterized by the presence of a conical ovipositor 2–3 mm. long, placed ventrally on the anterior third of the body, 2–3·5 mm. from the cephalic extremity, and by a spirally twisted tail, 2–3 mm. long, terminating in a fine point. Body semitransparent. Head tapering anteriorly. Mouth trilabiate; œsophagus long and terminating in a spherical bulb. Anus open ventrally at 3–4 mm. from tail-end. Eggs smooth, oblong, asymmetrical, and measuring 60–65  $\mu$  by 28–32  $\mu$ .

**SPARGANUM BAXTERI**, sp. n. ?

*Habitat.* Connective tissue of Man.

Long, flat, unsegmented body, 15 cm. long and 1·5 mm. broad, with numerous irregular transverse folds and a distinct longitudinal groove on ventral surface. Anterior extremity 2·5 mm. broad; head completely invaginated. Posterior extremity 2 mm. broad, with shallow median slit. Extracted from an abscess on the thigh of a Masai, British Central Africa.

**SCHISTOSOMUM MANSONI**, sp. n.

*Habitat.* Blood-vessels of Man.

In the Congo Free State, in other parts of Africa, and in the West Indies there is a form of Bilharziasis clinically and pathologically similar to the Asiatic form caused by *Schistosomum japonicum*, and unlike the classic East African form due to *S. hæmatobium*. The eggs of the species which causes this peculiar form are never found in the urine, but seem to be eliminated through the intestine only. They differ from those of *S. hæmatobium* in having a broad lateral spine totally different in size, shape, and position from the small, straight, terminal spine which characterises the ova of *S. hæmatobium*. Hitherto, the laterally spined ova, usually observed in Egypt in cases of mixed infection, have been looked upon as having been distorted whilst passing through the rectal mucosa. Sir Patrick Manson suggested several years ago, that the laterally spined ova found in the fæces of patients, and never in the urine, might represent a new species. In appreciation of this, one of his many genial intuitions, the new species is dedicated to him.

Dr. L. W. SAMBON also described five new Hæmogregarines discovered by himself and Dr. C. G. SELIGMANN in Snakes, as follows :—

**HÆMOGREGARINA POOCKI**, sp. n.

*Habitat.* Erythrocytes of Indian Python, *Python molurus* L.

Club-shaped, 14–16  $\mu$  long. Anterior extremity rounded, 3–15  $\mu$  broad. Posterior extremity attenuated and recurved. Cytoplasm more or less granular. Nucleus median or nearer posterior extremity, large, oval, and with coarse deeply staining chromatin

granules. Parasite lies parallel or obliquely to long axis of host-cell, of which it occupies about two-thirds, without causing much alteration beyond displacement of nucleus.

*HÆMOGREGARINA SHATTOCKI*, sp. n.

*Habitat.* Erythrocytes of Diamond Snake, *Python spilotes* (Lacép.).

Club-shaped. Some forms more slender, 14–15  $\mu$  long and 2  $\mu$  broad, with both extremities rounded and differing only slightly in thickness. Other forms more bulky, somewhat similar to those of *Python molurus*, but larger, 22  $\mu$  by 4  $\mu$ . Nucleus median and very large, 9  $\mu$  by 4  $\mu$ . Host-cell sometimes slightly distorted, nucleus pushed to the periphery.

*HÆMOGREGARINA REFRINGENS*, sp. n.

*Habitat.* Erythrocytes of Hoary Snake, *Pseudaspis cana* L.

Crescentic, bean-shaped, and discoidal forms occur. The slender crescentic forms have a long, oval, and more or less central nucleus. The bean-shaped forms measure 10–12  $\mu$  in length by 5–6  $\mu$  in width, they have a wide central nucleus, and their cytoplasm is literally crammed with rounded highly refractive granules. Host-cell unaltered beyond occasional displacement of nucleus.

*HÆMOGREGARINA MANSONI*, sp. n.

*Habitat.* Erythrocytes of Testaceous Snake, *Zamenis flagelliformis* L.

Oval or bean-shaped cyst 12–13  $\mu$  long by 5–6  $\mu$  broad, enclosing club-shaped parasite doubled up in the form of a letter U with both branches of equal length and closely applied. Nucleus median and situated near bend at one pole of cyst. Chromatin arranged in transverse parallel lines or in concentric circles. A characteristic feature is the almost constant presence of two large chromatoid granules usually placed one on each side of nucleus. Host-cell unaltered, nucleus slightly displaced.

*HÆMOGREGARINA RAREFACIENS*, sp. n.

*Habitat.* Erythrocytes and leucocytes of Couper's Snake, *Coluber corais* var. *couperi* Holbr.

1. Slender, elongate, cylindrical forms 14  $\mu$  long by 1.5  $\mu$  broad, sometimes presenting a refringent granule or vacuole at each extremity. Host-cell apparently unaltered or only slightly hypertrophied.

2. Large bean-forms 12–13  $\mu$  long by 4–5  $\mu$  broad, with cytoplasm more or less granular and occasionally vacuolated: Nucleus small, round, median, with fine chromatin grains. The host-cells containing this form measure about four times the normal size, are entirely dehaemoglobinized and greatly attenuated. Their nucleus is hypertrophied. Sometimes two or even three parasites may be found in the same host-cell.

A paper by Messrs. OLDFIELD THOMAS, F.R.S., F.Z.S., and R. C. WROUGHTON, F.Z.S., was read, giving an account of a collection of Mammals, the seventh of the series, made by Mr. C. H. B. Grant at Coguno, Inhambane, and presented to the National Museum by Mr. C. D. Rudd. The collection consisted of 212 specimens belonging to 39 species, of which six were described as new.

The next Meeting of the Society for Scientific Business will be held on Tuesday, the 9th April, 1907, at half-past Eight o'clock P.M., when the following communications will be made :—

1. Mr. T. A. COWARD, F.Z.S.—On the Winter Habits of the Greater Horseshoe and other Cave-haunting Bats.

2. Mr. G. A. BOULENGER, F.R.S.—On a small Collection of Fishes made in the Eastern Watershed of the Transvaal by Capt. G. E. Bruce.

3. Mr. W. P. PYCRAFT, F.Z.S.—Contributions to the Osteology of Birds.—Part VIII. Tyranni, Hirundines, Muscicapæ, Laniinæ, and Gymnorhines.

The following Papers have been received :—

1. Mr. C. J. WITH.—An Account of the South American *Cheliferinæ* in the Collections of the British and Copenhagen Museums.

2. Mons. S. A. BUTURLIN.—On some new or little-known Siberian Birds.

3. Mr. F. E. BEDDARD, F.R.S.—Notes upon the Anatomy of a Species of *Megalophrys*, with references to other Genera of Batrachia.

Communications intended for the Scientific Meetings of the ZOOLOGICAL SOCIETY OF LONDON should be addressed to

P. CHALMERS MITCHELL, *Secretary*.

3 HANOVER SQUARE, LONDON, W.

March 26th, 1907.

ABSTRACT OF THE PROCEEDINGS  
OF THE  
ZOOLOGICAL SOCIETY OF LONDON.\*

April 9th, 1907.

Dr. HENRY WOODWARD, F.R.S., Vice-President,  
in the Chair.

Mr. R. I. Pocock, the Superintendent of the Gardens, exhibited a photograph and the skull of the specimen of Pallas's Cat (*Felis manul*) that had recently died in the Menagerie.

Mr. G. A. BOULENGER, F.R.S., read a paper on a collection of Fishes made in the Eastern Watershed of the Transvaal by Capt. G. E. Bruce and presented by him to the British Museum. The collection contained specimens of 18 species, of which several had not been previously recorded from the Transvaal and five were new.

Mr. W. P. PYCRAFT, F.Z.S., read a paper on the Osteology of the Oligomyodian and Diacromyodian Passeres. After referring to his previous contribution (published in the 'Proceedings') on the Osteology of the Eurylæmid and Tracheophone Passeres, he remarked that there seemed little room for doubt but that the Diacromyodian and Oligomyodian Passeres must be regarded as divergent branches of a common stem.

The latter suborder included the Tyranniformes, Phytotomidæ, and Pittidæ, while the former embraced the remaining Passeres.

In the present communication some fourteen Families were

\* This Abstract is published by the Society at 3 Hanover Square, London, W., on the Tuesday following the date of Meeting to which it refers. It will be issued, free of extra charge, to all Fellows who subscribe to the Publications, along with the 'Proceedings'; but it may be obtained on the day of publication at the price of *Sixpence*, or, if desired, sent post-free for the sum of *Six Shillings* per annum, payable in advance.



described, and these were divided into four groups—Hirundines, Muscipapæ, Laniinæ, and Gymnorhinæ. This arrangement was based not on osteological characters alone, but also on the evidence of pterylosis and certain wing-muscles.

The author proposed to include the Vireonidæ with the Muscipapæ, and the Vireolaniidæ with the Gymnorhinæ. With this last group he proposed, tentatively at any rate, to include the Paradiseidæ, inasmuch as there seemed good reason for continuing to regard these birds as near allies of the Corvidæ.

Mr. F. E. BEDDARD, F.R.S., read a paper on the Anatomy of a Bornean Frog of the genus *Megalophrys*, with references to other genera of Batrachia.

Mr. T. A. COWARD, F.Z.S., communicated a paper on "The Winter Habits of the Greater Horseshoe and other Cave-haunting Bats," the result of observations made in the Somersetshire caverns, where at the end of December and beginning of January he found that the Bats were not in profound sleep, but moved in the caves and went into the open for food. This food, the author showed, was not all taken when the Bats were in flight, but was usually devoured when the Bats were at rest. The manner of feeding was described and information supplied about the food of the Greater Horseshoe and the parasites which infested this species and the Lesser Horseshoe.

The next Meeting of the Society for Scientific Business will be held on Tuesday, the 23rd April, 1907, at half-past Eight o'clock P.M., when the following communications will be made:—

1. Mons. S. A. BUTURLIN.—On some new or little-known Siberian Birds.

2. Mr. R. LYDEKKER, F.R.S., F.Z.S.—The EARS as a Race-character in the African Elephant.

3. Mr. OLDFIELD THOMAS, F.R.S., F.Z.S.—The Duke of Bedford's Zoological Exploration in Eastern Asia.—IV. List of small Mammals from the Islands of Saghalien and Hokkaido. With an Appendix on the Cold-blooded Vertebrates by Mr. G. A. BOULENGER, F.R.S., F.Z.S.

4. Mr. HENRY SCHERREN, F.Z.S.—Some Notes on Hybrid Bears.

The following Papers have been received :—

1. Mr. C. J. WITH.—An Account of the South American *Cheliferinæ* in the Collections of the British and Copenhagen Museums.

2. Mrs. O. A. MERRITT HAWKES.—On the Abdominal Viscera and a Vestigial Seventh Branchial Arch in *Chlamydoselachus*.

3. Mr. FRANK E. BEDDARD, F.R.S.—On some new Species of *Eudrilidæ* belonging to the Genera *Polytoreutus*, *Neumaniella*, and *Eminoscolex* from Mt. Ruwenzori.

4. Mr. OLDFIELD THOMAS, F.R.S.—The Duke of Bedford's Exploration in Eastern Asia.—V. Second List of Mammals from Korea.

Communications intended for the Scientific Meetings of the ZOOLOGICAL SOCIETY OF LONDON should be addressed to

P. CHALMERS MITCHELL, *Secretary*.

3 HANOVER SQUARE, LONDON, W.

*April 16th, 1907.*



ABSTRACT OF THE PROCEEDINGS  
OF THE  
ZOOLOGICAL SOCIETY OF LONDON.\*

April 23rd, 1907.

Dr. J. ROSE BRADFORD, F.R.S., Vice-President, in the Chair.

The SECRETARY read a report on the additions that had been made to the Menagerie in March 1907.

Dr. A. SMITH WOODWARD, F.R.S., exhibited an antler of a Red Deer which had become malformed and enlarged by disease. The specimen was obtained by Mr. Thomas Sheppard from a prehistoric peat-deposit at Mablethorpe, Lincolnshire.

Mr. R. I. Pocock exhibited, on behalf of the SECRETARY, a model of the African Elephant "Jumbo," formerly living in the Society's Menagerie, made by the late Mr. William Prehn and presented to the Society by his widow.

Mr. R. LYDEKKER, F.R.S., read a paper on the ears of the African Elephant as a race character, to illustrate which a large number of photographs and several specimens were exhibited. The author considered that there must be many more local races than those already named by Dr. Matschie, although, with the present material, he hesitated to give separate designations to several of these. He ventured, however, to propose new names for the Elephant of the eastern side of Cape Colony; for that of Mashonaland, as typified by a head in the Imperial Institute; for that of the Lake Rudolf district, as represented by a head presented to the British Museum by Mr. H. S. H. Cavendish; and for the Somali Elephant, as typified by a head in the collection of S.A.R. le Duc d'Orléans at Wood Norton, this last race being characterised by the very small ears, which, however, were quite different in shape from those of *E. a. knochenhaueri*.

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The author also directed special attention to a skull from the Albert Nyanza district, for which he had previously suggested the name *E. a. albertensis*. Differing in many points from those of other African elephants, this skull showed a remarkable resemblance to that of the extinct Indian *E. planifrons*, thus suggesting the descent of the African Elephant from that species.

Mr. H. E. DRESSER, F.Z.S., communicated a paper by Mons. S. A. BUTURLIN containing descriptions of three new species and five new subspecies of Siberian Birds.

Mr. OLDFIELD THOMAS, F.R.S., read a list of small mammals which had been obtained in the Islands of Saghalien and Hokkaido by Mr. M. P. Anderson, for the Duke of Bedford's exploration of Eastern Asia. Fourteen species were recorded from Saghalien and thirteen from Hokkaido. The faunas of the two islands proved to be very similar to each other, although in some cases subspecific differences between the representative forms in each were perceptible. In one genus only, *Micromys*, the relationship of Hokkaido seemed to be with the main island of Japan rather than with Saghalien.

A list of the cold-blooded Vertebrates of Saghalien, by Mr. G. A. BOULENGER, F.R.S., was also read.

Mr. HENRY SCHERREN, F.Z.S., read some notes on Hybrid Bears, referring to cases that had occurred in the Society's Gardens, the long series bred by Herr Nill in his Zoological Garden at Stuttgart (now broken up), and a recent case in the Garden at Halle-an-der-Saale. Reference was also made to cases said to have occurred at Cologne and Hanover, but for these the evidence was not conclusive.

Mr. F. E. BEDDARD, F.R.S., contributed a paper on some new species of Earthworms of the family Eudrilidae, belonging to the genera *Polytoreutus*, *Neumaniella*, and *Eminoscolex* from Mt. Ruwenzori.

A communication from Mr. C. J. WITH contained an account of the South-American Pseudo-scorpions of the family Cheliferidae in the collections of the British and Copenhagen Museums.

The next Meeting of the Society for Scientific Business will be held on Tuesday, the 7th May, 1907, at half-past Eight o'clock P.M., when the following communications will be made:—

1. Mr. OLDFIELD THOMAS, F.R.S.—The Duke of Bedford's Exploration in Eastern Asia.—V. Second List of Mammals from Korea.

2. Mr. AUBYN R. B. TREVOR-BATTYE, F.Z.S.—On some Constructional Features in Continental Zoological Gardens.

3. Dr. WILLIAM E. HOYLE.—The Marine Fauna of Zanzibar and East Africa, from Collections made by Cyril Crossland in 1901–1902.—Cephalopoda.

The following Papers have been received :—

1. Mrs. O. A. MERRITT HAWKES.—On the Abdominal Viscera and a Vestigial Seventh Branchial Arch in *Chlamydoselachus*.

2. Mr. JAMES RITCHIE, M.A.—Some Collections of the Cape Verde Islands Marine Fauna, made by Cyril Crossland, July to September 1904.—Hydroids.

Communications intended for the Scientific Meetings of the ZOOLOGICAL SOCIETY OF LONDON should be addressed to

P. CHALMERS MITCHELL, *Secretary*.

3 HANOVER SQUARE, LONDON, W.

*April 30th, 1907.*



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